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(54) Title: METHODS OF INHIBITING DESICCATION OF CUTTINGS REMOVED FROM ORNAMENTAL PLANTS

(57) Abstract: Disclosed are methods of inhibiting desiccation of cuttings from ornamental plants, methods of harvesting cuttings from ornamental plants, methods of promoting early flowering of ornamental plants, and methods of enhancing the longevity of flower blooms on ornamental plant cuttings. The ornamental plants can be transgenic plants which express a heterologous hypersensitive response elicitor protein or polypeptide or the ornamental plants can be treated via topical application with a hypersensitive response elicitor protein or polypeptide. Alternatively, cuttings from the ornamental plant can be treated with a hypersensitive response elicitor protein or polypeptide, independent of any treatment provided to the ornamental plant from which the cutting is removed.

METHODS OF INHIBITING DESICCATION OF CUTTINGS REMOVED FROM ORNAMENTAL PLANTS

5 This application claims benefit of U.S. Provisional Patent Application
Serial No. 60/248,169, filed November 13, 2000, which is hereby incorporated by
reference in its entirety.

FIELD OF THE INVENTION

10 The present invention generally relates to methods of treating
ornamental plants or cuttings removed therefrom to inhibit desiccation of cuttings
removed from the ornamental plants.

BACKGROUND OF THE INVENTION

15 According to an April 2001 report by the United States Department of
Agriculture, National Agricultural Statistics Service, Sp Cr 6-1 (01), entitled
"Floriculture Crops: 2000 Summary", during the previous year the wholesale value of
domestically produced cut flowers was \$427 million. The top three valued cut flower
20 categories were Roses at \$69.4 million, Lilies at \$58.6 million, and Gladioli at \$32.2
million. While the U.S. cut flower industry is not insignificant, two-thirds of the cut
flowers sold in the U.S. in 1998 were imported, and this import market was worth \$1
billion. Of the imports coming into the U.S. that year, 56% were from Colombia,
22% from elsewhere in Central & South America, and about 18% from The
25 Netherlands.

Postharvest handling methods that were developed over 20 years ago
on U.S. produced flowers are still current practice in the fresh flower industry.
However, as noted above, many flowers sold in the U.S. today are imported from
Colombia and Ecuador and can be 8-10 days old when purchased by consumers.
30 Current problems with cut flower longevity and quality are associated with shifts in
the geographical locations of production, introduction of new varieties, long-distance
transport from farm to consumer, improper transport and storage temperatures, and
undesirable handling practices. With respect to transport and storage temperatures,

prevalent problems include: flowers are often not pre-cooled adequately when they leave the grower; use of non-refrigerated trucks during shipment; boxed flowers which sit for extended periods on non-refrigerated docks; and flowers are not kept cool during air transport.

- 5 The effect that these problems can have on cut flower longevity includes not only poor appearance of flowers at retail sites, but also loss of flowers (i.e., wilting or dying) prior to the time they reach the retailer or shortly thereafter. In either case, the wholesaler or the retailer may realize financial losses as a result.

A number of strategies have been devised to minimize flower loss.

- 10 These include treatment with silver thiosulfate, 1-methylcyclopropene (MCP), carboxymethoxylamine (also known as aminooxyacetic acid (AOAA)), AVG, N-AVG, rhizobitoxine, or *L*-trans-2-amino-4-methoxy-3-butenic acid (MVG). Silver thiosulfate and MCP are believed to inhibit the effect of either internal or external ethylene, while the others are believed to act internally to inhibit the ability of the cut
15 flowers, plants, and fruit to produce ethylene. These compounds (except MCP) are typically applied to plants or plant materials in the form of an aqueous treatment solution. Applications of the treatment solution to potted plants are carried out by spraying it onto the aerial parts of the plants or by including it in the irrigation water which is supplied to their roots. Treatment of cut flowers or greens is typically carried
20 out by immersing the cut ends of the stems in the aqueous solution containing the treating agent immediately after harvest, during transportation or while the floral arrangement is on display, although they might be treated by immersing the whole flowers into a solution or by spraying them. Since MCP is a gas, it cannot readily be applied in aqueous solution, so plants are treated by exposing them to a modified,
25 controlled atmosphere (containing a defined amount of MCP) in an enclosed chamber.

Silver thiosulfate is expensive and it may be toxic to animals.

Although MCP is now commercially available, its use is limited due to difficulties in application and its lack of stability.

- 30 However effective these earlier attempts to reduce cut flower losses, there still exists a need to provide improved, non-toxic and easily practiced approaches for minimizing the losses of ornamental plant cuttings. The present invention is directed to overcoming these deficiencies in the art.

SUMMARY OF THE INVENTION

A first aspect of the present invention relates to a method of inhibiting desiccation of cuttings from ornamental plants which includes: treating an ornamental
5 plant with a hypersensitive response elicitor protein or polypeptide under conditions effective to inhibit desiccation of a cutting from the ornamental plant after the cutting is removed from the ornamental plant.

A second aspect of the present invention relates to a cutting which has been removed from an ornamental plant treated with a hypersensitive response elicitor
10 protein or polypeptide, wherein the cutting is characterized by greater resistance to desiccation as compared to a cutting removed from an untreated ornamental plant.

A third aspect of the present invention relates to a method of promoting early flowering of an ornamental plant which includes: treating an ornamental plant with a hypersensitive response elicitor protein or polypeptide under
15 conditions effective to promote early flowering of the ornamental plant.

A fourth aspect of the present invention relates to a method of harvesting a cutting from an ornamental plant which includes: treating an ornamental plant with a hypersensitive response elicitor protein or polypeptide and harvesting a
cutting from the treated ornamental plant.

A fifth aspect of the present invention relates to a method of harvesting a cutting from an ornamental plant which includes: harvesting a cutting from an ornamental plant and treating the harvested cutting with a hypersensitive response
20 elicitor protein or polypeptide.

A sixth aspect of the present invention relates to a method of inhibiting desiccation of cuttings from ornamental plants which includes: removing a cutting
25 from an ornamental plant and treating the removed cutting with a hypersensitive response elicitor protein or polypeptide under conditions effective to inhibit desiccation of the removed cutting.

A seventh aspect of the present invention relates to a cutting which has been removed from an ornamental plant, wherein the cutting has been treated with a hypersensitive response elicitor protein or polypeptide and wherein the cutting is
30 characterized by greater resistance to desiccation as compared to an untreated cutting removed from the ornamental plant.

An eighth aspect of the present invention relates to a method of inhibiting desiccation of cuttings from ornamental plants which includes: providing a transgenic ornamental plant or plant seed transformed with a DNA molecule encoding a hypersensitive response elicitor polypeptide or protein and growing the transgenic ornamental plant or transgenic ornamental plant produced from the transgenic ornamental plant seed under conditions effective to inhibit desiccation in a cutting removed from the transgenic plant.

A ninth aspect of the present invention relates to a method of promoting early flowering of an ornamental plant which includes: providing a transgenic ornamental plant or plant seed transformed with a DNA molecule encoding a hypersensitive response elicitor polypeptide or protein and growing the transgenic ornamental plant or transgenic ornamental plant produced from the transgenic ornamental plant seed under conditions effective to promote early flowering of the transgenic ornamental plant.

A tenth aspect of the present invention relates to a method of harvesting a cutting from an ornamental plant which includes: providing a transgenic ornamental plant or plant seed transformed with a DNA molecule encoding a hypersensitive response elicitor polypeptide or protein; growing the transgenic ornamental plant or transgenic ornamental plant produced from the transgenic ornamental plant seed under conditions; and harvesting a cutting from the grown transgenic ornamental plant, wherein the cutting exhibits a reduced susceptibility to desiccation as compared to cuttings removed from non-transgenic ornamental plants.

An eleventh aspect of the present invention relates to a cutting which has been removed from a transgenic ornamental plant which expresses a heterologous hypersensitive response elicitor protein or polypeptide, wherein the cutting is characterized by greater resistance to desiccation as compared to a cutting removed from a non-transgenic ornamental plant.

A twelfth aspect of the present invention relates to a method of enhancing the longevity of flower blooms on ornamental plant cuttings which includes: providing a transgenic ornamental plant or plant seed transformed with a DNA molecule encoding a hypersensitive response elicitor polypeptide or protein and growing the transgenic ornamental plant or transgenic ornamental plant produced

from the transgenic ornamental plant seed under conditions effective to enhancing the longevity of flower blooms on cuttings removed therefrom.

A thirteenth aspect of the present invention relates to a method of enhancing the longevity of flower blooms on ornamental plant cuttings which includes: treating an ornamental plant with a hypersensitive response elicitor protein or polypeptide under conditions effective to enhancing the longevity of flower blooms on cuttings removed therefrom.

A fourteenth aspect of the present invention relates to a method of enhancing the longevity of flower blooms on ornamental plant cuttings which includes: harvesting a cutting from an ornamental plant and treating the harvested cutting with a hypersensitive response elicitor protein or polypeptide under conditions effective to enhancing the longevity of flower blooms on the harvested cutting.

Because hypersensitive response elicitor proteins or polypeptides can easily be expressed transgenically in or applied topically to ornamental plants and/or ornamental plant cuttings, the present invention offers an effective, simple-to-use, non-toxic approach for inhibiting the desiccation of cuttings removed from ornamental plants, promoting early flowering of the ornamental plants, and enhancing the longevity of flower blooms on ornamental plant cuttings. By inhibiting desiccation of cuttings after they have been removed from an ornamental plant, the cuttings are less likely to wilt and die before they are received by the retailer. This will dramatically decrease losses associated with long transportation rates in less than ideal conditions. Moreover, it is also possible to enhancing the longevity of flower blooms, which end consumers can clearly appreciate.

25

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an image illustrating the response of *Vega* roses to pre- and postharvest application of EBC-151 (left), untreated (center), and preharvest only treatment with EBC-151. Image captured 16 days after harvest and postharvest treatment with EBC-151.

Figure 2 is an image illustrating the response of *Vega* roses to pre-harvest only applications of EBC-151; 150 + 350 g/Ha (left), untreated (center), and

250 g/Ha (right). Image captured 16 days after harvest; no postharvest treatment applied.

Figure 3 is an image illustrating the response of *Vega* roses to postharvest only application of EBC-151. Image captured 16 days after harvest.

5

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to methods of inhibiting desiccation of cuttings from ornamental plants, methods of harvesting cuttings from ornamental
10 plants, methods of promoting early flowering of ornamental plants, and methods of enhancing the longevity of flower blooms on ornamental plant cuttings.

The ornamental plants can be transgenic plants which express a heterologous hypersensitive response elicitor protein or polypeptide or the ornamental plants can be treated (i.e., via topical application) with a hypersensitive response
15 elicitor protein or polypeptide. Alternatively, the cutting from the ornamental plant (whether transgenic or not) can itself be treated with a hypersensitive response elicitor protein or polypeptide, independent of any treatment provided to the ornamental plant from which the cutting is removed.

For use in accordance with these methods, suitable hypersensitive
20 response elicitor proteins or polypeptides are those derived from a wide variety of bacterial and fungal pathogens, preferably bacterial pathogens.

Exemplary hypersensitive response elicitor proteins and polypeptides from bacterial sources include, without limitation, the hypersensitive response elicitors derived from *Erwinia* species (e.g., *Erwinia amylovora*, *Erwinia*
25 *chrysanthemi*, *Erwinia stewartii*, *Erwinia carotovora*, etc.), *Pseudomonas* species (e.g., *Pseudomonas syringae*), *Ralstonia* species (e.g., *Ralstonia solanacearum*), and *Xanthomonas* species (e.g., *Xanthomonas campestris*). In addition to hypersensitive response elicitors from these Gram-negative bacteria, it is possible to use elicitors derived from Gram-positive bacteria. One example is the hypersensitive response
30 elicitor derived from *Clavibacter michiganensis* subsp. *sepedonicus*.

Exemplary hypersensitive response elicitor proteins or polypeptides from fungal sources include, without limitation, the hypersensitive response elicitors (i.e., elicitors) from various *Phytophthora* species (e.g., *Phytophthora parasitica*,

Phytophthora cryptogea, *Phytophthora cinnamomi*, *Phytophthora capsici*,
Phytophthora megasperma, *Phytophthora citrophthora*, etc.).

Preferably, the hypersensitive response elicitor protein or polypeptide
 is derived from *Erwinia chrysanthemi*, *Erwinia amylovora*, *Pseudomonas syringae*,
 5 *Ralstonia solanacearum*, or *Xanthomonas campestris*.

A hypersensitive response elicitor protein or polypeptide from *Erwinia*
chrysanthemi has an amino acid sequence corresponding to SEQ. ID. No. 1 as
 follows:

10	Met	Gln	Ile	Thr	Ile	Lys	Ala	His	Ile	Gly	Gly	Asp	Leu	Gly	Val	Ser	1	5	10	15
	Gly	Leu	Gly	Ala	Gln	Gly	Leu	Lys	Gly	Leu	Asn	Ser	Ala	Ala	Ser	Ser	20	25	30	
15	Leu	Gly	Ser	Ser	Val	Asp	Lys	Leu	Ser	Ser	Thr	Ile	Asp	Lys	Leu	Thr	35	40	45	
	Ser	Ala	Leu	Thr	Ser	Met	Met	Phe	Gly	Gly	Ala	Leu	Ala	Gln	Gly	Leu	50	55	60	
20	Gly	Ala	Ser	Ser	Lys	Gly	Leu	Gly	Met	Ser	Asn	Gln	Leu	Gly	Gln	Ser	65	70	75	80
	Phe	Gly	Asn	Gly	Ala	Gln	Gly	Ala	Ser	Asn	Leu	Leu	Ser	Val	Pro	Lys	85	90	95	
	Ser	Gly	Gly	Asp	Ala	Leu	Ser	Lys	Met	Phe	Asp	Lys	Ala	Leu	Asp	Asp	100	105	110	
25	Leu	Leu	Gly	His	Asp	Thr	Val	Thr	Lys	Leu	Thr	Asn	Gln	Ser	Asn	Gln	115	120	125	
	Leu	Ala	Asn	Ser	Met	Leu	Asn	Ala	Ser	Gln	Met	Thr	Gln	Gly	Asn	Met	130	135	140	
30	Asn	Ala	Phe	Gly	Ser	Gly	Val	Asn	Asn	Ala	Leu	Ser	Ser	Ile	Leu	Gly	145	150	155	160
	Asn	Gly	Leu	Gly	Gln	Ser	Met	Ser	Gly	Phe	Ser	Gln	Pro	Ser	Leu	Gly	165	170	175	
	Ala	Gly	Gly	Leu	Gln	Gly	Leu	Ser	Gly	Ala	Gly	Ala	Phe	Asn	Gln	Leu	180	185	190	
35	Gly	Asn	Ala	Ile	Gly	Met	Gly	Val	Gly	Gln	Asn	Ala	Ala	Leu	Ser	Ala	195	200	205	
	Leu	Ser	Asn	Val	Ser	Thr	His	Val	Asp	Gly	Asn	Asn	Arg	His	Phe	Val	210	215	220	

	Asp	Lys	Glu	Asp	Arg	Gly	Met	Ala	Lys	Glu	Ile	Gly	Gln	Phe	Met	Asp	
	225					230					235					240	
	Gln	Tyr	Pro	Glu	Ile	Phe	Gly	Lys	Pro	Glu	Tyr	Gln	Lys	Asp	Gly	Trp	
					245					250					255		
5	Ser	Ser	Pro	Lys	Thr	Asp	Asp	Lys	Ser	Trp	Ala	Lys	Ala	Leu	Ser	Lys	
				260					265					270			
	Pro	Asp	Asp	Asp	Gly	Met	Thr	Gly	Ala	Ser	Met	Asp	Lys	Phe	Arg	Gln	
				275				280					285				
10	Ala	Met	Gly	Met	Ile	Lys	Ser	Ala	Val	Ala	Gly	Asp	Thr	Gly	Asn	Thr	
	290					295						300					
	Asn	Leu	Asn	Leu	Arg	Gly	Ala	Gly	Gly	Ala	Ser	Leu	Gly	Ile	Asp	Ala	
	305					310					315					320	
	Ala	Val	Val	Gly	Asp	Lys	Ile	Ala	Asn	Met	Ser	Leu	Gly	Lys	Leu	Ala	
				325					330						335		
15	Asn	Ala															

This hypersensitive response elicitor protein or polypeptide has a molecular mass of 34 kDa, is heat stable, has a glycine content of greater than 16%, and contains substantially no cysteine. This *Erwinia chrysanthemi* hypersensitive response elicitor protein or polypeptide is encoded by a DNA molecule having a nucleotide sequence corresponding to SEQ. ID. No. 2 as follows:

	cgattttacc	cgggtgaacg	tgctatgacc	gacagcatca	cggtattcga	caccggttacg	60
25	gcgtttatgg	ccgcgatgaa	ccggcatcag	gcggcgcgct	ggtcgccgca	atccggcgctc	120
	gatctggtat	ttcagtttgg	ggacaccggg	cgtgaactca	tgatgcagat	tcagccggggg	180
	cagcaatatc	ccggcatggt	gcgcacgctg	ctcgctcgctc	gttatcagca	ggcggcagag	240
	tgcgatggct	gccatctgtg	cctgaacggc	agcgatgtat	tgatcctctg	gtggccgctg	300
	ccgtcggatc	ccggcagtta	tccgcagggtg	atcgaaacgtt	tgtttgaact	ggcgggaatg	360
30	acgttgccgt	cgctatccat	agcaccgacg	gcgcgtccgc	agacagggaa	cggacgcgcc	420
	cgatcattaa	gataaaggcg	gcttttttta	ttgcaaaacg	gtaacgggtga	ggaaccgtttt	480
	caccgtcggc	gtcactcagt	aacaagtatc	catcatgatg	cctacatcgg	gatcggcgctg	540
	ggcatccgtt	gcagataact	ttgcgaacac	ctgacatgaa	tgaggaaacg	aaattatgca	600
	aattacgatc	aaagcgcaca	tgggcggtga	tttgggcgctc	tccggtctgg	ggctgggtgc	660
35	tcagggactg	aaaggactga	attccgcggc	ttcatcgctg	ggttccagcg	tggataaact	720
	gagcagcacc	atcgataagt	tgacctccgc	gctgacttcg	atgatgtttg	gcggcgcgct	780
	ggcgcagggg	ctgggcgcca	gctcgaaggg	gctggggatg	agcaatcaac	tgggccagtc	840
	tttcggcaat	ggcgcgcagg	gtgcgagcaa	cctgctatcc	gtaccgaaat	ccggcggcga	900
	tgcgttgtca	aaaatgtttg	ataaagcgct	ggacgatctg	ctgggtcatg	acaccgtgac	960
40	caagctgact	aaccagagca	accaactggc	taattcaatg	ctgaacgcca	gccagatgac	1020
	ccagggtaat	atgaatgcgt	tgggcagcgg	tgtgaacaac	gcactgtcgt	ccattctcgg	1080
	caacggtctc	ggccagtcga	tgagtggctt	ctctcagcct	tctctggggg	caggcgggctt	1140

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gcagggcctg agcggcgcggt gtgcattcaa ccagttgggt aatgccatcg gcatggggcgt 1200
ggggcagaat gctgcgctga gtgcgttgag taacgtcagc acccacgtag acggtaacaa 1260
ccgccacttt gtagataaag aagatcgcggt catggcgaaa gagatcggcc agtttatgga 1320
tcagtatccg gaaatattcg gtaaaccgga ataccagaaa gatggctgga gttcgccgaa 1380
5 gacggacgac aaatcctggg ctaaagcggt gagtaaaccg gatgatgacg gtatgaccgg 1440
cgccagcatg gacaaattcc gtcaggcgat gggatgatc aaaagcgcggt tggcgggtga 1500
taccggcaat accaacctga acctgcgtgg cgcggggcgt gcatcgctgg gtatcgatgc 1560
ggctgtcgtc ggcgataaaa tagccaacat gtcgctgggt aagctggcca acgcctgata 1620
atctgtgctg gcctgataaa gcggaaacga aaaaagagac ggggaagcct gtctcttttc 1680
10 ttattatgcg gtttatgcgg ttacctggac cggttaatca tcgtcatcga tctggtacaa 1740
acgcacattt tcccgttcat tcgctcggtt acgcgccaca atcgcgatgg catcttcctc 1800
gtcgtcaga ttgcgcgggt gatggggaac gccgggtgga atatatagaa actcgccggc 1860
cagatggaga cacgtctgctg ataaatctgt gccgtaacgt gtttctatcc gccccttag 1920
cagatagatt gcggtttcgt aatcaacatg gtaaatgcgt tccgcctgtg cgcggcgccg 1980
15 gatcaccaca atattcatag aaagctgtct tgcacctacc gtatcgcggt agataccgac 2040
aaaatagggc agtttttgcg tggatccgt ggggtgttcc ggcctgacaa tcttgagttg 2100
gttcgtcatc atctttctcc atctgggcga cctgatcggt t 2141

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The above nucleotide and amino acid sequences are disclosed and further described in U.S. Patent No. 5,850,015 to Bauer et al. and U.S. Patent No. 5,776,889 to Wei et al., each of which is hereby incorporated by reference in its entirety.

A hypersensitive response elicitor protein or polypeptide derived from *Erwinia amylovora* has an amino acid sequence corresponding to SEQ. ID. No. 3 as follows:

```

Met Ser Leu Asn Thr Ser Gly Leu Gly Ala Ser Thr Met Gln Ile Ser
1          5          10          15
Ile Gly Gly Ala Gly Gly Asn Asn Gly Leu Leu Gly Thr Ser Arg Gln
20          25          30
Asn Ala Gly Leu Gly Gly Asn Ser Ala Leu Gly Leu Gly Gly Gly Asn
35          40          45
Gln Asn Asp Thr Val Asn Gln Leu Ala Gly Leu Leu Thr Gly Met Met
50          55          60
35 Met Met Met Ser Met Met Gly Gly Gly Gly Leu Met Gly Gly Gly Leu
65          70          75          80
Gly Gly Gly Leu Gly Asn Gly Leu Gly Gly Ser Gly Gly Leu Gly Glu
85          90          95
40 Gly Leu Ser Asn Ala Leu Asn Asp Met Leu Gly Gly Ser Leu Asn Thr
100          105          110

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	Leu Gly Ser Lys Gly Gly Asn Asn Thr Thr Ser Thr Thr Asn Ser Pro	115	120	125
	Leu Asp Gln Ala Leu Gly Ile Asn Ser Thr Ser Gln Asn Asp Asp Ser	130	135	140
5	Thr Ser Gly Thr Asp Ser Thr Ser Asp Ser Ser Asp Pro Met Gln Gln	145	150	155
	Leu Leu Lys Met Phe Ser Glu Ile Met Gln Ser Leu Phe Gly Asp Gly	165	170	175
10	Gln Asp Gly Thr Gln Gly Ser Ser Ser Gly Gly Lys Gln Pro Thr Glu	180	185	190
	Gly Glu Gln Asn Ala Tyr Lys Lys Gly Val Thr Asp Ala Leu Ser Gly	195	200	205
	Leu Met Gly Asn Gly Leu Ser Gln Leu Leu Gly Asn Gly Gly Leu Gly	210	215	220
15	Gly Gly Gln Gly Gly Asn Ala Gly Thr Gly Leu Asp Gly Ser Ser Leu	225	230	235
	Gly Gly Lys Gly Leu Gln Asn Leu Ser Gly Pro Val Asp Tyr Gln Gln	245	250	255
20	Leu Gly Asn Ala Val Gly Thr Gly Ile Gly Met Lys Ala Gly Ile Gln	260	265	270
	Ala Leu Asn Asp Ile Gly Thr His Arg His Ser Ser Thr Arg Ser Phe	275	280	285
	Val Asn Lys Gly Asp Arg Ala Met Ala Lys Glu Ile Gly Gln Phe Met	290	295	300
25	Asp Gln Tyr Pro Glu Val Phe Gly Lys Pro Gln Tyr Gln Lys Gly Pro	305	310	315
	Gly Gln Glu Val Lys Thr Asp Asp Lys Ser Trp Ala Lys Ala Leu Ser	325	330	335
30	Lys Pro Asp Asp Asp Gly Met Thr Pro Ala Ser Met Glu Gln Phe Asn	340	345	350
	Lys Ala Lys Gly Met Ile Lys Arg Pro Met Ala Gly Asp Thr Gly Asn	355	360	365
	Gly Asn Leu Gln Ala Arg Gly Ala Gly Gly Ser Ser Leu Gly Ile Asp	370	375	380
35	Ala Met Met Ala Gly Asp Ala Ile Asn Asn Met Ala Leu Gly Lys Leu	385	390	395
	Gly Ala Ala			400

This hypersensitive response elicitor protein or polypeptide has a molecular mass of about 39 kDa, has a pI of approximately 4.3, and is heat stable at 100°C for at least 10 minutes. This hypersensitive response elicitor protein or polypeptide has substantially no cysteine. The hypersensitive response elicitor protein or polypeptide derived from *Erwinia amylovora* is more fully described in Wei, Z-M., et al., "Harpin, Elicitor of the Hypersensitive Response Produced by the Plant Pathogen *Erwinia amylovora*," *Science* 257:85-88 (1992), which is hereby incorporated by reference in its entirety. The DNA molecule encoding this hypersensitive response elicitor protein or polypeptide has a nucleotide sequence corresponding to SEQ. ID. No. 4 as follows:

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aagcttcggc atggcacgtt tgaccgttgg gtcggcaggg tacgtttgaa ttattcataa      60
gaggaatacg ttatgagtct gaatacaagt gggctgggag cgtcaacgat gcaaatttct      120
atcggcgggtg cgggcggaaa taacgggttg ctgggtacca gtcgccagaa tgctgggttg      180
15 ggtggcaatt ctgactggg gctgggcggc ggtaatcaaa atgataccgt caatcagctg      240
gctggccttac tcaccggcat gatgatgatg atgagcatga tgggcggtgg tgggctgatg      300
ggcgggtggct taggcggtgg cttaggtaat ggcttgggtg gctcaggtgg cctgggcgaa      360
ggactgtcga acgcgctgaa cgatatgtta ggcgggttcgc tgaacacgct gggctcgaaa      420
ggcggcaaca ataccacttc aacaacaaat tccccgctgg accaggcgct gggattatac      480
20 tcaacgtccc aaaacgacga ttccacctcc ggcacagatt ccacctcaga ctccagcgac      540
ccgatgcagc agctgctgaa gatgttcagc gagataatgc aaagcctgtt tggatgatggg      600
caagatggca cccagggcag ttctctctggg ggcaagcagc cgaccgaagg cgagcagaac      660
gcctataaaa aaggagtcac tgatgcgctg tcgggcctga tgggtaatgg tctgagccag      720
ctccttggca acgggggact gggaggtggg cagggcggtg atgctggcac gggctctgac      780
25 ggttcgtcgc tgggcggcaa agggctgcaa aacctgagcg ggccggtgga ctaccagcag      840
ttaggtaacg ccgtgggtac cggatcgggt atgaaagcgg gcattcaggc gctgaatgat      900
atcggtaacg acaggcacag ttcaaccctg tctttcgtca ataaaggcga tcgggcgatg      960
gcgaaggaaa tcggtcagtt catggaccag tatcctgagg tgtttggcaa gccgcagtac      1020
cagaaaggcc cgggtcagga ggtgaaaacc gatgacaaat catgggcaaa agcactgagc      1080
30 aagccagatg acgacggaat gacaccagcc agtatggagc agttcaacaa agccaagggc      1140
atgatcaaaa ggcccatggc gggatgatac ggcaacggca acctgcaggc acgcggtgcc      1200
ggtggttctt cgctgggtat tgatgccatg atggccgggtg atgccattaa caatatggca      1260
cttggcaagc tgggcgcggc ttaagctt                                     1288

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The above nucleotide and amino acid sequences are disclosed are further described in U.S. Patent No. 5,849,868 to Beer et al. and U.S. Patent No. 5,776,889 to Wei et al., each of which is hereby incorporated by reference in its entirety.

Another hypersensitive response elicitor protein or polypeptide derived from *Erwinia amylovora* has an amino acid sequence corresponding to SEQ. ID. No. 5 as follows:

5	Met	Ser	Ile	Leu	Thr	Leu	Asn	Asn	Asn	Thr	Ser	Ser	Ser	Pro	Gly	Leu	1	5	10	15
	Phe	Gln	Ser	Gly	Gly	Asp	Asn	Gly	Leu	Gly	Gly	His	Asn	Ala	Asn	Ser	20	25	30	
10	Ala	Leu	Gly	Gln	Gln	Pro	Ile	Asp	Arg	Gln	Thr	Ile	Glu	Gln	Met	Ala	35	40	45	
	Gln	Leu	Leu	Ala	Glu	Leu	Leu	Lys	Ser	Leu	Leu	Ser	Pro	Gln	Ser	Gly	50	55	60	
15	Asn	Ala	Ala	Thr	Gly	Ala	Gly	Gly	Asn	Asp	Gln	Thr	Thr	Gly	Val	Gly	65	70	75	80
20	Asn	Ala	Gly	Gly	Leu	Asn	Gly	Arg	Lys	Gly	Thr	Ala	Gly	Thr	Thr	Pro	85	90	95	
	Gln	Ser	Asp	Ser	Gln	Asn	Met	Leu	Ser	Glu	Met	Gly	Asn	Asn	Gly	Leu	100	105	110	
25	Asp	Gln	Ala	Ile	Thr	Pro	Asp	Gly	Gln	Gly	Gly	Gly	Gln	Ile	Gly	Asp	115	120	125	
	Asn	Pro	Leu	Leu	Lys	Ala	Met	Leu	Lys	Leu	Ile	Ala	Arg	Met	Met	Asp	130	135	140	
30	Gly	Gln	Ser	Asp	Gln	Phe	Gly	Gln	Pro	Gly	Thr	Gly	Asn	Asn	Ser	Ala	145	150	155	160
35	Ser	Ser	Gly	Thr	Ser	Ser	Ser	Gly	Gly	Ser	Pro	Phe	Asn	Asp	Leu	Ser	165	170	175	
	Gly	Gly	Lys	Ala	Pro	Ser	Gly	Asn	Ser	Pro	Ser	Gly	Asn	Tyr	Ser	Pro	180	185	190	
40	Val	Ser	Thr	Phe	Ser	Pro	Pro	Ser	Thr	Pro	Thr	Ser	Pro	Thr	Ser	Pro	195	200	205	
	Leu	Asp	Phe	Pro	Ser	Ser	Pro	Thr	Lys	Ala	Ala	Gly	Gly	Ser	Thr	Pro	210	215	220	
45	Val	Thr	Asp	His	Pro	Asp	Pro	Val	Gly	Ser	Ala	Gly	Ile	Gly	Ala	Gly	225	230	235	240
50	Asn	Ser	Val	Ala	Phe	Thr	Ser	Ala	Gly	Ala	Asn	Gln	Thr	Val	Leu	His	245	250	255	
	Asp	Thr	Ile	Thr	Val	Lys	Ala	Gly	Gln	Val	Phe	Asp	Gly	Lys	Gly	Gln	260	265	270	
55	Thr	Phe	Thr	Ala	Gly	Ser	Glu	Leu	Gly	Asp	Gly	Gly	Gln	Ser	Glu	Asn	275	280	285	

	Gln	Lys	Pro	Leu	Phe	Ile	Leu	Glu	Asp	Gly	Ala	Ser	Leu	Lys	Asn	Val	
	290						295					300					
5	Thr	Met	Gly	Asp	Asp	Gly	Ala	Asp	Gly	Ile	His	Leu	Tyr	Gly	Asp	Ala	
	305					310					315					320	
	Lys	Ile	Asp	Asn	Leu	His	Val	Thr	Asn	Val	Gly	Glu	Asp	Ala	Ile	Thr	
					325					330					335		
10	Val	Lys	Pro	Asn	Ser	Ala	Gly	Lys	Lys	Ser	His	Val	Glu	Ile	Thr	Asn	
				340					345					350			
	Ser	Ser	Phe	Glu	His	Ala	Ser	Asp	Lys	Ile	Leu	Gln	Leu	Asn	Ala	Asp	
15			355					360					365				
	Thr	Asn	Leu	Ser	Val	Asp	Asn	Val	Lys	Ala	Lys	Asp	Phe	Gly	Thr	Phe	
	370						375					380					
20	Val	Arg	Thr	Asn	Gly	Gly	Gln	Gln	Gly	Asn	Trp	Asp	Leu	Asn	Leu	Ser	
	385					390					395					400	
	His	Ile	Ser	Ala	Glu	Asp	Gly	Lys	Phe	Ser	Phe	Val	Lys	Ser	Asp	Ser	
				405						410					415		
25	Glu	Gly	Leu	Asn	Val	Asn	Thr	Ser	Asp	Ile	Ser	Leu	Gly	Asp	Val	Glu	
				420					425					430			
	Asn	His	Tyr	Lys	Val	Pro	Met	Ser	Ala	Asn	Leu	Lys	Val	Ala	Glu		
30			435					440					445				

This protein or polypeptide is acidic, rich in glycine and serine, and lacks cysteine. It is also heat stable, protease sensitive, and suppressed by inhibitors of plant metabolism. The protein or polypeptide of the present invention has a predicted molecular mass of ca. 45 kDa. The DNA molecule encoding this hypersensitive response elicitor protein or polypeptide has a nucleotide sequence corresponding to SEQ. ID. No. 6 as follows:

40	atgtcaattc	ttacgcttaa	caacaatacc	togtctctgc	cgggtctggt	ccagtccggg	60
	ggggacaacg	ggcttggtgg	tcataatgca	aattctgcgt	tggggcaaca	acccatcgat	120
	cggcaaacca	ttgagcaaat	ggctcaatta	ttggcggaac	tgtaaagtc	actgctatcg	180
	ccacaatcag	gtaatgcggc	aaccggagcc	ggtggcaatg	accagactac	aggagtgtgt	240
	aacgctggcg	gcctgaacgg	acgaaaaggc	acagcaggaa	ccactccgca	gtctgacagt	300
45	cagaacatgc	tgagtgagat	gggcaacaac	gggctggatc	aggccatcac	gcccgatggc	360
	cagggcggcg	ggcagatcgg	cgataatcct	ttactgaaag	ccatgctgaa	gcttattgca	420
	cgcgatgatg	acggccaaag	cgatcagttt	ggccaacctg	gtacgggcaa	caacagtgcc	480
	tcttccggta	cttcttcac	tggcggttcc	ccttttaacg	atctatcagg	ggggaaggcc	540
	ccttccggca	actccccttc	cggcaactac	tctcccgtea	gtaccttctc	acccccatcc	600
50	acgccaacgt	cccctacctc	accgcttgat	ttcccttctt	ctcccaccaa	agcagccggg	660
	ggcagcacgc	cggtaaccga	tcatactgac	cctgttggtg	gcgcgggcat	cggggccgga	720

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aattcggtagg ccttcaccag cgccggcgct aatcagacgg tgctgcatga caccattacc 780
gtgaaagcgg gtcagggtgtt tgatggcaaa ggacaaacct tcaccgccgg ttcagaatta 840
ggcgaatggcg gccagtctga aaaccagaaa ccgctgttta tactggaaga cgggtgccagc 900
ctgaaaaacg tcaccatggg cgacgacggg gcggatggta ttcattctta cgggtgatgcc 960
5  aaaatagaca atctgcacgt caccaacgtg ggtgaggacg cgattaccgt taagccaaac 1020
agcgcggggca aaaaatccca cgttgaaatc actaacagtt ccttcgagca cgctctgac 1080
aagatcctgc agctgaatgc cgataactaac ctgagcgttg acaacgtgaa ggccaaagac 1140
tttggtactt ttgtacgcac taacggcggt caacagggta actgggatct gaatctgagc 1200
catatcagcg cagaagacgg taagttctcg ttcgttaaaa gcgatagcga ggggctaaac 1260
10 gtcaatacca gtgatatctc actgggtgat gttgaaaacc actacaaagt gccgatgtcc 1320
gccaacctga aggtggctga atga 1344

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The above nucleotide and amino acid sequences are disclosed and further described in U.S. Patent No. 6,262,018 to Kim et al., which is hereby incorporated by reference in its entirety.

A hypersensitive response elicitor protein or polypeptide derived from *Pseudomonas syringae* has an amino acid sequence corresponding to SEQ. ID. No. 7 as follows:

```

20  Met Gln Ser Leu Ser Leu Asn Ser Ser Ser Leu Gln Thr Pro Ala Met
    1              5              10              15

    Ala Leu Val Leu Val Arg Pro Glu Ala Glu Thr Thr Gly Ser Thr Ser
    20              25              30

25  Ser Lys Ala Leu Gln Glu Val Val Val Lys Leu Ala Glu Glu Leu Met
    35              40              45

    Arg Asn Gly Gln Leu Asp Asp Ser Ser Pro Leu Gly Lys Leu Leu Ala
    50              55              60

30  Lys Ser Met Ala Ala Asp Gly Lys Ala Gly Gly Gly Ile Glu Asp Val
    65              70              75              80

    Ile Ala Ala Leu Asp Lys Leu Ile His Glu Lys Leu Gly Asp Asn Phe
    85              90              95

    Gly Ala Ser Ala Asp Ser Ala Ser Gly Thr Gly Gln Gln Asp Leu Met
    100             105             110

35  Thr Gln Val Leu Asn Gly Leu Ala Lys Ser Met Leu Asp Asp Leu Leu
    115             120             125

    Thr Lys Gln Asp Gly Gly Thr Ser Phe Ser Glu Asp Asp Met Pro Met
    130             135             140

40  Leu Asn Lys Ile Ala Gln Phe Met Asp Asp Asn Pro Ala Gln Phe Pro
    145             150             155             160

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Lys Pro Asp Ser Gly Ser Trp Val Asn Glu Leu Lys Glu Asp Asn Phe
 165 170 175
 Leu Asp Gly Asp Glu Thr Ala Ala Phe Arg Ser Ala Leu Asp Ile Ile
 180 185 190
 5 Gly Gln Gln Leu Gly Asn Gln Gln Ser Asp Ala Gly Ser Leu Ala Gly
 195 200 205
 Thr Gly Gly Gly Leu Gly Thr Pro Ser Ser Phe Ser Asn Asn Ser Ser
 210 215 220
 10 Val Met Gly Asp Pro Leu Ile Asp Ala Asn Thr Gly Pro Gly Asp Ser
 225 230 235 240
 Gly Asn Thr Arg Gly Glu Ala Gly Gln Leu Ile Gly Glu Leu Ile Asp
 245 250 255
 Arg Gly Leu Gln Ser Val Leu Ala Gly Gly Gly Leu Gly Thr Pro Val
 260 265 270
 15 Asn Thr Pro Gln Thr Gly Thr Ser Ala Asn Gly Gly Gln Ser Ala Gln
 275 280 285
 Asp Leu Asp Gln Leu Leu Gly Gly Leu Leu Leu Lys Gly Leu Glu Ala
 290 295 300
 20 Thr Leu Lys Asp Ala Gly Gln Thr Gly Thr Asp Val Gln Ser Ser Ala
 305 310 315 320
 Ala Gln Ile Ala Thr Leu Leu Val Ser Thr Leu Leu Gln Gly Thr Arg
 325 330 335
 Asn Gln Ala Ala Ala
 340

25

This hypersensitive response elicitor protein or polypeptide has a
 molecular mass of 34-35 kDa. It is rich in glycine (about 13.5%) and lacks cysteine
 and tyrosine. Further information about the hypersensitive response elicitor derived
 from *Pseudomonas syringae* is found in He, S. Y., et al., "*Pseudomonas syringae* pv.
 30 *syringae* Harpin_{PS}: a Protein that is Secreted via the Hrp Pathway and Elicits the
 Hypersensitive Response in Plants," *Cell* 73:1255-1266 (1993), which is hereby
 incorporated by reference in its entirety. The DNA molecule encoding this
 hypersensitive response elicitor from *Pseudomonas syringae* has a nucleotide
 sequence corresponding to SEQ. ID. No. 8 as follows:

35

atgcagagtc tcagtccttaa cagcagctcg ctgcaaacc cggcaatggc ccttgctcctg 60
 gtacgtcctg aagccgagac gactggcagt acgtcgagca aggcgcttca ggaagttgtc 120
 gtgaagctgg ccgaggaact gatgcgcaat ggtcaactcg acgacagctc gccattggga 180

	aaactgttgg	ccaagtcgat	ggccgcagat	ggcaaggcgg	gcggcggtat	tgaggatgtc	240
	atcgctgcgc	tggacaagct	gatccatgaa	aagctcgggtg	acaacttcgg	cgctctgcg	300
	gacagcgctt	cgggtaccgg	acagcaggac	ctgatgactc	aggtgctcaa	tgccctggcc	360
	aagtcgatgc	tcgatgatct	tctgaccaag	caggatggcg	ggacaagctt	ctccgaagac	420
5	gatatgccga	tgctgaacaa	gatcgcgcag	ttcatggatg	acaatcccgc	acagtttccc	480
	aagccggact	cgggctcctg	ggtgaacgaa	ctcaagggaag	acaacttctt	tgatggcgac	540
	gaaacggctg	cgttccgttc	ggcactcgac	atcattggcc	agcaactggg	taatcagcag	600
	agtgaagctg	gcagtctggc	agggacgggt	ggaggctctg	gcactccgag	cagtttttcc	660
	aacaactcgt	ccgtgatggg	tgatccgctg	atcgacgcca	ataccgggtcc	cggtgacagc	720
10	ggcaataccc	gtggtgaagc	ggggcaactg	atcggcgagc	ttatcgaccg	tgccctgcaa	780
	tcggtatttg	ccggtggtgg	actgggcaca	cccgtaaaca	ccccgcagac	cggtacgtcg	840
	gcgaatggcg	gacagtcgcg	tcaggatctt	gatcagttgc	tgggcggctt	gctgctcaag	900
	ggcctggagg	caacgctcaa	ggatgccggg	caaacaggca	ccgacgtgca	gtcgagcgct	960
	gcgcaaatac	ccaccttgct	ggtcagtagc	ctgctgcaag	gcacccgcaa	tcaggctgca	1020
15	gcctga						1026

The above nucleotide and amino acid sequences are disclosed and further described in U.S. Patent No. 5,708,139 to Collmer et al. and U.S. Patent No. 5,776,889 to Wei et al., each of which is hereby incorporated by reference in its entirety.

Another hypersensitive response elicitor protein or polypeptide derived from *Pseudomonas syringae* has an amino acid sequence corresponding to SEQ. ID. No. 9 as follows:

25	Met	Ser	Ile	Gly	Ile	Thr	Pro	Arg	Pro	Gln	Gln	Thr	Thr	Thr	Pro	Leu
	1				5					10					15	
	Asp	Phe	Ser	Ala	Leu	Ser	Gly	Lys	Ser	Pro	Gln	Pro	Asn	Thr	Phe	Gly
				20					25					30		
30	Glu	Gln	Asn	Thr	Gln	Gln	Ala	Ile	Asp	Pro	Ser	Ala	Leu	Leu	Phe	Gly
			35				40						45			
	Ser	Asp	Thr	Gln	Lys	Asp	Val	Asn	Phe	Gly	Thr	Pro	Asp	Ser	Thr	Val
35		50					55					60				
	Gln	Asn	Pro	Gln	Asp	Ala	Ser	Lys	Pro	Asn	Asp	Ser	Gln	Ser	Asn	Ile
	65					70					75				80	
40	Ala	Lys	Leu	Ile	Ser	Ala	Leu	Ile	Met	Ser	Leu	Leu	Gln	Met	Leu	Thr
					85					90					95	
	Asn	Ser	Asn	Lys	Lys	Gln	Asp	Thr	Asn	Gln	Glu	Gln	Pro	Asp	Ser	Gln
				100					105					110		
45	Ala	Pro	Phe	Gln	Asn	Asn	Gly	Gly	Leu	Gly	Thr	Pro	Ser	Ala	Asp	Ser
				115				120						125		

	Gly	Gly	Gly	Gly	Thr	Pro	Asp	Ala	Thr	Gly	Gly	Gly	Gly	Gly	Asp	Thr	
	130						135					140					
5	Pro	Ser	Ala	Thr	Gly	Gly	Gly	Gly	Gly	Asp	Thr	Pro	Thr	Ala	Thr	Gly	
	145					150				155						160	
	Gly	Gly	Gly	Ser	Gly	Gly	Gly	Gly	Thr	Pro	Thr	Ala	Thr	Gly	Gly	Gly	
					165					170					175		
10	Ser	Gly	Gly	Thr	Pro	Thr	Ala	Thr	Gly	Gly	Gly	Glu	Gly	Gly	Val	Thr	
				180					185					190			
	Pro	Gln	Ile	Thr	Pro	Gln	Leu	Ala	Asn	Pro	Asn	Arg	Thr	Ser	Gly	Thr	
15				195				200					205				
	Gly	Ser	Val	Ser	Asp	Thr	Ala	Gly	Ser	Thr	Glu	Gln	Ala	Gly	Lys	Ile	
	210						215					220					
20	Asn	Val	Val	Lys	Asp	Thr	Ile	Lys	Val	Gly	Ala	Gly	Glu	Val	Phe	Asp	
	225					230					235					240	
	Gly	His	Gly	Ala	Thr	Phe	Thr	Ala	Asp	Lys	Ser	Met	Gly	Asn	Gly	Asp	
					245					250					255		
25	Gln	Gly	Glu	Asn	Gln	Lys	Pro	Met	Phe	Glu	Leu	Ala	Glu	Gly	Ala	Thr	
				260					265					270			
	Leu	Lys	Asn	Val	Asn	Leu	Gly	Glu	Asn	Glu	Val	Asp	Gly	Ile	His	Val	
30				275				280					285				
	Lys	Ala	Lys	Asn	Ala	Gln	Glu	Val	Thr	Ile	Asp	Asn	Val	His	Ala	Gln	
		290					295					300					
35	Asn	Val	Gly	Glu	Asp	Leu	Ile	Thr	Val	Lys	Gly	Glu	Gly	Gly	Ala	Ala	
	305					310					315					320	
	Val	Thr	Asn	Leu	Asn	Ile	Lys	Asn	Ser	Ser	Ala	Lys	Gly	Ala	Asp	Asp	
					325					330					335		
40	Lys	Val	Val	Gln	Leu	Asn	Ala	Asn	Thr	His	Leu	Lys	Ile	Asp	Asn	Phe	
				340					345					350			
	Lys	Ala	Asp	Asp	Phe	Gly	Thr	Met	Val	Arg	Thr	Asn	Gly	Gly	Lys	Gln	
45			355					360					365				
	Phe	Asp	Asp	Met	Ser	Ile	Glu	Leu	Asn	Gly	Ile	Glu	Ala	Asn	His	Gly	
		370					375					380					
50	Lys	Phe	Ala	Leu	Val	Lys	Ser	Asp	Ser	Asp	Asp	Leu	Lys	Leu	Ala	Thr	
	385					390					395					400	
	Gly	Asn	Ile	Ala	Met	Thr	Asp	Val	Lys	His	Ala	Tyr	Asp	Lys	Thr	Gln	
					405					410					415		
55	Ala	Ser	Thr	Gln	His	Thr	Glu	Leu									
							420										

This protein or polypeptide is acidic, glycine-rich, lacks cysteine, and is deficient in aromatic amino acids. The DNA molecule encoding this hypersensitive

response elicitor from *Pseudomonas syringae* has a nucleotide sequence corresponding to SEQ. ID. No. 10 as follows:

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tccaacttcgc tgattttgaa attggcagat tcatagaaac gttcaggtgt ggaaatcagg 60
5 ctgagtgcgc agatttcgtt gataaggggt tggtactggt cattgttggt catttcaagg 120
cctctgagtg cgggtgcggag caataccagt cttcctgctg gcgtgtgcac actgagtcgc 180
aggcataggc atttcagttc cttgcgttgg ttgggcatat aaaaaaagga acttttaaaa 240
acagtgcaat gagatgccgg caaaacggga accggtcgct gcgctttgcc actcacttcg 300
agcaagctca accccaaaca tccacatccc tatcgaacgg acagcgatac ggccacttgc 360
10 tctggtaaac cctggagctg gcgtcggtcc aattgccac ttagcgaggt aacgcagcat 420
gagcatcggc atcacacccc ggccgcaaca gaccaccacg ccactcgatt tttcggcgct 480
aagcggcaag agtcctcaac caaacacgtt cggcgagcag aacactcagc aagcgatcga 540
cccagtgca ctgttggtcg gcagcgacac acagaaagac gtcaacttcg gcacgcccga 600
cagcaccgtc cagaatccgc aggacgccag caagcccaac gacagccagt ccaacatcgc 660
15 taaattgatc agtgcattga tcatgtcgtt gctgcagatg ctcaccaact ccaataaaaa 720
gcaggacacc aatcaggaac agcctgatag ccaggctcct ttccagaaca acggcgggct 780
cggtacaccg tcggccgata gcggggcgcg cggtacaccg gatgcgacag gtggcggcg 840
cggtgatacg ccaagcgcaa caggcggtgg cggcggtgat actccgaccg caacaggcg 900
tggcggcagc ggtggcgcg gcacaccac tgcaacaggt ggcggcagcg gtggcacacc 960
20 cactgcaaca ggcggtggcg aggggtggcg aacaccgcaa atcactccgc agttggccaa 1020
ccctaaccgt acctcaggta ctggctcggg gtcggacacc gcaggttcta ccgagcaagc 1080
cggcaagatc aatgtggtga aagacaccat caaggtcggc gctggcgaag tctttgacgg 1140
ccacggcgca accttactg ccgacaaatc tatgggtaac ggagaccagg gcgaaaatca 1200
gaagcccatg ttcgagctgg ctgaaggcgc tacgttgaag aatgtgaacc tgggtgagaa 1260
25 cgaggctgat ggcattccag tgaaagccaa aaacgctcag gaagtcacca ttgacaacgt 1320
gcatgcccg aacgtcggtg aagacctgat tacggtcaaa ggcgaggag gcgcagcggt 1380
cactaatctg aacatcaaga acagcagtg caaaggtgca gacgacaagg ttgtccagct 1440
caacgccaac actcacttga aaatcgacaa cttcaaggcc gacgatttcg gcacgatggt 1500
tcgcaccaac ggtggcaagc agtttgatga catgagcatc gagctgaacg gcatcgaagc 1560
30 taaccacggc aagttcgccc tggtgaaaag cgacagtga gatctgaagc tggcaacggg 1620
caacatcgcc atgaccgacg tcaaacacgc ctacgataaa acccaggcat cgaccaaca 1680
caccgagctt tgaatccaga caagtagctt gaaaaaagg ggtggactc 1729

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35 The above nucleotide and amino acid sequences are disclosed and further described in U.S. Patent No. 6,172,184 to Collmer et al., which is hereby incorporated by reference in its entirety.

A hypersensitive response elicitor protein or polypeptide derived from *Ralstonia solanacearum* has an amino acid sequence corresponding to SEQ. ID. No. 11 as follows:

```

Met Ser Val Gly Asn Ile Gln Ser Pro Ser Asn Leu Pro Gly Leu Gln
1           5           10          15

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	Asn	Leu	Asn	Leu	Asn	Thr	Asn	Thr	Asn	Ser	Gln	Gln	Ser	Gly	Gln	Ser	
					20				25					30			
	Val	Gln	Asp	Leu	Ile	Lys	Gln	Val	Glu	Lys	Asp	Ile	Leu	Asn	Ile	Ile	
			35					40					45				
5	Ala	Ala	Leu	Val	Gln	Lys	Ala	Ala	Gln	Ser	Ala	Gly	Gly	Asn	Thr	Gly	
			50				55					60					
	Asn	Thr	Gly	Asn	Ala	Pro	Ala	Lys	Asp	Gly	Asn	Ala	Asn	Ala	Gly	Ala	
			65			70				75					80		
10	Asn	Asp	Pro	Ser	Lys	Asn	Asp	Pro	Ser	Lys	Ser	Gln	Ala	Pro	Gln	Ser	
					85					90					95		
	Ala	Asn	Lys	Thr	Gly	Asn	Val	Asp	Asp	Ala	Asn	Asn	Gln	Asp	Pro	Met	
					100				105					110			
	Gln	Ala	Leu	Met	Gln	Leu	Leu	Glu	Asp	Leu	Val	Lys	Leu	Leu	Lys	Ala	
					115			120					125				
15	Ala	Leu	His	Met	Gln	Gln	Pro	Gly	Gly	Asn	Asp	Lys	Gly	Asn	Gly	Val	
							135					140					
	Gly	Gly	Ala	Asn	Gly	Ala	Lys	Gly	Ala	Gly	Gly	Gln	Gly	Gly	Leu	Ala	
						150					155					160	
20	Glu	Ala	Leu	Gln	Glu	Ile	Glu	Gln	Ile	Leu	Ala	Gln	Leu	Gly	Gly	Gly	
					165					170					175		
	Gly	Ala	Gly	Ala	Gly	Gly	Ala	Gly	Gly	Gly	Val	Gly	Gly	Ala	Gly	Gly	
					180				185					190			
	Ala	Asp	Gly	Gly	Ser	Gly	Ala	Gly	Gly	Ala	Gly	Gly	Ala	Asn	Gly	Ala	
					195			200					205				
25	Asp	Gly	Gly	Asn	Gly	Val	Asn	Gly	Asn	Gln	Ala	Asn	Gly	Pro	Gln	Asn	
							215					220					
	Ala	Gly	Asp	Val	Asn	Gly	Ala	Asn	Gly	Ala	Asp	Asp	Gly	Ser	Glu	Asp	
						230					235					240	
30	Gln	Gly	Gly	Leu	Thr	Gly	Val	Leu	Gln	Lys	Leu	Met	Lys	Ile	Leu	Asn	
					245					250					255		
	Ala	Leu	Val	Gln	Met	Met	Gln	Gln	Gly	Gly	Leu	Gly	Gly	Gly	Asn	Gln	
					260				265					270			
	Ala	Gln	Gly	Gly	Ser	Lys	Gly	Ala	Gly	Asn	Ala	Ser	Pro	Ala	Ser	Gly	
					275			280					285				
35	Ala	Asn	Pro	Gly	Ala	Asn	Gln	Pro	Gly	Ser	Ala	Asp	Asp	Gln	Ser	Ser	
					290		295					300					
	Gly	Gln	Asn	Asn	Leu	Gln	Ser	Gln	Ile	Met	Asp	Val	Val	Lys	Glu	Val	
						310				315					320		
40	Val	Gln	Ile	Leu	Gln	Gln	Met	Leu	Ala	Ala	Gln	Asn	Gly	Gly	Ser	Gln	
					325					330					335		

Gln Ser Thr Ser Thr Gln Pro Met
340

Further information regarding this hypersensitive response elicitor protein or polypeptide derived from *Ralstonia solanacearum* is set forth in Arlat, M., et al., "PopA1, a Protein which Induces a Hypersensitive-like Response in Specific Petunia Genotypes, is Secreted via the Hrp Pathway of *Pseudomonas solanacearum*," EMBO J. 13:543-533 (1994), which is hereby incorporated by reference in its entirety. It is encoded by a DNA molecule from *Ralstonia solanacearum* having a nucleotide sequence corresponding SEQ. ID. No. 12 as follows:

atgtcagtcg gaaacatcca gagcccgctcg aacctcccgg gtctgcagaa cctgaacctc 60
aacaccaaca ccaacagcca gcaatcgggc cagtccgtgc aagacctgat caagcaggctc 120
gagaaggaca tcctcaacat catcgcagcc ctctgtcaga aggccgcaca gtcggcgggc 180
15 ggcaacaccg gtaacaccgg caacgcgcgg gcgaaggacg gcaatgccaa cgcgggcggc 240
aacgacccga gcaagaacga cccgagcaag agccaggctc cgcagtcggc caacaagacc 300
ggcaacgtcg acgacgcca caaccaggat ccgatgcaag cgtgatgca gctgctggaa 360
gacctggtga agctgctgaa ggcggccctg cacatgcagc agcccgggcg caatgacaag 420
ggcaacggcg tgggcgggtg caacggcgcc aagggtgccg gcggccaggc cggcctggcc 480
20 gaagcgctgc aggagatcga gcagatcctc gccagctcg gcggcgggcg tgctggcgcc 540
ggcgcgcgcg gtggcggtgt cggcggtgct ggtggcgcg atggcggtc cggcgcggt 600
ggcgcgaggc gtgcgaacgg cgcgcagggc ggcaatggcg tgaacggcaa ccaggcgaac 660
ggccgcgaga acgcaggcga tgtcaacggt gccaacggcg cggatgacgg cagcgaagac 720
caggcgggcc tcaccggcgt gctgcaaaag ctgatgaaga tcctgaacgc gctggtgcag 780
25 atgatgcagc aaggcggcct cggcgggcggc aaccaggcgc agggcggtc gaagggtgcc 840
ggcaacgcct cgcgggcttc cggcgcgaa cggcgcgcg accagcccgg tcggcggtat 900
gatcaatcgt ccggccagaa caatctgcaa tcccagatca tggatgtggt gaaggaggtc 960
gtccagatcc tgcagcagat gctggcgggc cagaacggcg gcagccagca gtccacctcg 1020
acgcagccga tgtaa 1035
30

The above nucleotide and amino acid sequences are disclosed and further described in U.S. Patent No. 5,776,889 to Wei et al., which is hereby incorporated by reference in its entirety.

A hypersensitive response elicitor protein or polypeptide derived from *Xanthomonas campestris* has an amino acid sequence corresponding to SEQ. ID. No. 13 as follows:

Met Asp Ser Ile Gly Asn Asn Phe Ser Asn Ile Gly Asn Leu Gln Thr
1 5 10 15

Met Gly Ile Gly Pro Gln Gln His Glu Asp Ser Ser Gln Gln Ser Pro
 20 25 30
 Ser Ala Gly Ser Glu Gln Gln Leu Asp Gln Leu Leu Ala Met Phe Ile
 5 35 40 45
 Met Met Met Leu Gln Gln Ser Gln Gly Ser Asp Ala Asn Gln Glu Cys
 50 55 60
 Gly Asn Glu Gln Pro Gln Asn Gly Gln Gln Glu Gly Leu Ser Pro Leu
 10 65 70 75 80
 Thr Gln Met Leu Met Gln Ile Val Met Gln Leu Met Gln Asn Gln Gly
 15 85 90 95
 Gly Ala Gly Met Gly Gly Gly Gly Ser Val Asn Ser Ser Leu Gly Gly
 100 105 110
 Asn Ala
 20

This hypersensitive response elicitor protein has an estimated
 molecular mass of about 12 kDa based on the deduced amino acid sequence, which is
 consistent with the molecular mass of about 14 kDa as detected by SDS-PAGE. It is
 25 encoded by a DNA molecule from *Xanthomonas campestris* having a nucleotide
 sequence corresponding SEQ. ID. No. 14 as follows:

atggactcta tcggaaacaa cttttcgaat atcggcaacc tgcagacgat gggcatcggg 60
 cctcagcaac acgaggactc cagccagcag tcgccttcgg ctggctccga gcagcagctg 120
 30 gatcagttgc tcgcatgtt catcatgatg atgctgcaac agagccaggg cagcgatgca 180
 aatcaggagt gtggcaacga acaaccgcag aacggtcaac aggaaggcct gaggccgttg 240
 acgcagatgc tgatgcagat cgtgatgcag ctgatgcaga accagggcgg cgccggcatg 300
 ggcggtggcg gttcgggtcaa cagcagcctg ggcggcaacg cc 342

35 The above protein and nucleic acid molecule are further described in
 U.S. Patent Application Serial No. 09/412,452 to Wei et al., filed April 9, 2001, which
 is hereby incorporated by reference in its entirety.

Other embodiments of the present invention include, but are not
 limited to, use of hypersensitive response elicitor proteins or polypeptides derived
 40 from *Erwinia carotovora* and *Erwinia stewartii*. Isolation of an *Erwinia carotovora*
 hypersensitive response elicitor protein or polypeptide is described in Cui, et al., "The
 RsmA Mutants of *Erwinia carotovora* subsp. *carotovora* Strain Ecc71 Overexpress
hrpN_{Ecc} and Elicit a Hypersensitive Reaction-like Response in Tobacco Leaves,"

MPML, 9(7):565-73 (1996), which is hereby incorporated by reference in its entirety.

A hypersensitive response elicitor protein or polypeptide of *Erwinia stewartii* is set forth in Ahmad, et al., "Harpin is Not Necessary for the Pathogenicity of *Erwinia stewartii* on Maize," 8th Int'l. Cong. Molec. Plant-Microbe Interact., July 14-19, 1996
5 and Ahmad, et al., "Harpin is Not Necessary for the Pathogenicity of *Erwinia stewartii* on Maize," Ann. Mtg. Am. Phytopath. Soc., July 27-31, 1996, each of which is hereby incorporated by reference in its entirety.

Hypersensitive response elicitor proteins or polypeptides from various *Phytophthora* species are described in Kaman, et al., "Extracellular Protein Elicitors
10 from *Phytophthora*: Most Specificity and Induction of Resistance to Bacterial and Fungal Phytopathogens," Molec. Plant-Microbe Interact., 6(1):15-25 (1993); Ricci, et al., "Structure and Activity of Proteins from Pathogenic Fungi *Phytophthora* Eliciting Necrosis and Acquired Resistance in Tobacco," Eur. J. Biochem., 183:555-63 (1989); Ricci, et al., "Differential Production of Parasiticein, and Elicitor of Necrosis and
15 Resistance in Tobacco, by Isolates of *Phytophthora parasitica*," Plant Path. 41:298-307 (1992); Bailleul, et al., "A New Elicitor of the Hypersensitive Response in Tobacco: A Fungal Glycoprotein Elicits Cell Death, Expression of Defense Genes, Production of Salicylic Acid, and Induction of Systemic Acquired Resistance," Plant J., 8(4):551-60 (1995), and Bonnet, et al., "Acquired Resistance Triggered by
20 Elicitors in Tobacco and Other Plants," Eur. J. Plant Path., 102:181-92 (1996), each of which is hereby incorporated by reference in its entirety.

Another hypersensitive response elicitor protein or polypeptide which can be used in accordance with the present invention is derived from *Clavibacter michiganensis* subsp. *sepedonicus* and is described in U.S. Patent Application Serial
25 No. 09/136,625 to Beer et al., filed August 19, 1998, which is hereby incorporated by reference in its entirety.

Fragments of the above hypersensitive response elicitor proteins or polypeptides as well as fragments of full length elicitors from other pathogens can also be used according to the present invention.

30 Suitable fragments can be produced by several means. Subclones of the gene encoding a known elicitor protein can be produced using conventional molecular genetic manipulation for subcloning gene fragments, such as described by Sambrook et al., Molecular Cloning: A Laboratory Manual, Cold Springs Laboratory,

Cold Springs Harbor, New York (1989), and Ausubel et al. (ed.), Current Protocols in Molecular Biology, John Wiley & Sons (New York, NY) (1999 and preceding editions), each of which is hereby incorporated by reference in its entirety. The subclones then are expressed *in vitro* or *in vivo* in bacterial cells to yield a smaller
5 protein or polypeptide that can be tested for elicitor activity, e.g., using procedures set forth in Wei, Z-M., et al., Science 257: 85-88 (1992), which is hereby incorporated by reference in its entirety.

In another approach, based on knowledge of the primary structure of the protein, fragments of the elicitor protein gene may be synthesized using the PCR
10 technique together with specific sets of primers chosen to represent particular portions of the protein. Erlich, H.A., et al., "Recent Advances in the Polymerase Chain Reaction," Science 252:1643-51 (1991), which is hereby incorporated by reference in its entirety. These can then be cloned into an appropriate vector for expression of a truncated protein or polypeptide from bacterial cells as described above.

15 As an alternative, fragments of an elicitor protein can be produced by digestion of a full-length elicitor protein with proteolytic enzymes like chymotrypsin or *Staphylococcus* proteinase A, or trypsin. Different proteolytic enzymes are likely to cleave elicitor proteins at different sites based on the amino acid sequence of the elicitor protein. Some of the fragments that result from proteolysis may be active
20 elicitors of resistance.

Chemical synthesis can also be used to make suitable fragments. Such a synthesis is carried out using known amino acid sequences for the elicitor being produced. Alternatively, subjecting a full length elicitor to high temperatures and pressures will produce fragments. These fragments can then be separated by
25 conventional procedures (e.g., chromatography, SDS-PAGE).

An example of suitable fragments of a hypersensitive response elicitor which elicit a hypersensitive response are fragments of the *Erwinia amylovora* hypersensitive response elicitor protein or polypeptide of SEQ. ID. No. 3. The fragments can be a C-terminal fragment of the amino acid sequence of SEQ. ID. No.
30 3, an N-terminal fragment of the amino acid sequence of SEQ. ID. No. 3, or an internal fragment of the amino acid sequence of SEQ. ID. No. 3. The C-terminal fragment of the amino acid sequence of SEQ. ID. No. 3 can span amino acids 105 and 403 of SEQ. ID. No. 3. The N-terminal fragment of the amino acid sequence of SEQ.

ID. No. 3 can span the following amino acids of SEQ. ID. No. 3: 1 and 98, 1 and 104, 1 and 122, 1 and 168, 1 and 218, 1 and 266, 1 and 342, 1 and 321, and 1 and 372. The internal fragment of the amino acid sequence of SEQ. ID. No. 3 can span the following amino acids of SEQ. ID. No. 3: 76 and 209, 105 and 209, 99 and 209, 137 and 204, 137 and 200, 109 and 204, 109 and 200, 137 and 180, and 105 and 180. DNA molecules encoding these fragments can also be utilized in a chimeric gene of the present invention.

Variants may also (or alternatively) be modified by, for example, the deletion or addition of amino acids that have minimal influence on the properties, secondary structure and hydropathic nature of the polypeptide. For example, a polypeptide may be conjugated to a signal (or leader) sequence at the N-terminal end of the protein which co-translationally or post-translationally directs transfer of the protein. The polypeptide may also be conjugated to a linker or other sequence for ease of synthesis, purification, or identification of the polypeptide.

The hypersensitive response elicitor proteins or polypeptides used in accordance with the present invention are preferably produced in purified form (preferably at least about 80%, more preferably 90%, pure) by conventional techniques. Typically, the protein or polypeptide of the present invention is produced but not secreted into growth medium. In such cases, to isolate the protein, the host cell (e.g., *E. coli*) carrying a recombinant plasmid is propagated, lysed by sonication, heat, or chemical treatment, and the homogenate is centrifuged to remove bacterial debris. The supernatant is then subjected to sequential ammonium sulfate precipitation. The fraction containing the hypersensitive response elicitor protein or polypeptide of interest is subjected to gel filtration in an appropriately sized dextran or polyacrylamide column to separate the proteins. If necessary, the protein fraction may be further purified by HPLC. Alternatively, the protein or polypeptide of the present invention is secreted into the growth medium of recombinant host cells (discussed *infra*) and removed therefrom.

One particular hypersensitive response elicitor protein, known as harpin_{Ea}, is commercially available from Eden Bioscience Corporation (Bothell, Washington) under the name of Messenger[®]. Messenger[®] contains 3% by weight of harpin_{Ea} as the active ingredient and 97% by weight inert ingredients. Harpin_{Ea} is one

type of hypersensitive response elicitor protein from *Erwinia amylovora*, identified herein by SEQ. ID. No. 3.

Other hypersensitive response elicitors can be readily identified by isolating putative protein or polypeptide candidates and testing them for elicitor activity as described, for example, in Wei, Z-M., et al., "Harpin, Elicitor of the Hypersensitive Response Produced by the Plant Pathogen *Erwinia amylovora*," Science 257:85-88 (1992), which is hereby incorporated by reference in its entirety. Cell-free preparations from culture supernatants can be tested for elicitor activity (i.e., local necrosis) by using them to infiltrate appropriate plant tissues. Once identified, DNA molecules encoding a hypersensitive response elicitor can be isolated using standard techniques known to those skilled in the art.

DNA molecules encoding other hypersensitive response elicitor proteins or polypeptides can also be identified by determining whether such DNA molecules hybridizes under stringent conditions to a DNA molecule having the nucleotide sequence of SEQ. ID. Nos. 2, 4, 6, 8, 10, 12, or 14. An example of suitable stringency conditions is when hybridization is carried out at a temperature of about 37°C using a hybridization medium that includes 0.9M sodium citrate ("SSC") buffer, followed by washing with 0.2x SSC buffer at 37°C. Higher stringency can readily be attained by increasing the temperature for either hybridization or washing conditions or increasing the sodium concentration of the hybridization or wash medium. Nonspecific binding may also be controlled using any one of a number of known techniques such as, for example, blocking the membrane with protein-containing solutions, addition of heterologous RNA, DNA, and SDS to the hybridization buffer, and treatment with RNase. Wash conditions are typically performed at or below stringency. Exemplary high stringency conditions include carrying out hybridization at a temperature of about 42°C to about 65°C for up to about 20 hours in a hybridization medium containing 1M NaCl, 50 mM Tris-HCl, pH 7.4, 10 mM EDTA, 0.1% sodium dodecyl sulfate (SDS), 0.2% ficoll, 0.2% polyvinylpyrrolidone, 0.2% bovine serum albumin, and 50 µg/ml *E. coli* DNA, followed by washing carried out at between about 42°C to about 65°C in a 0.2x SSC buffer.

The DNA molecule encoding the hypersensitive response elicitor polypeptide or protein can be incorporated in cells using conventional recombinant DNA technology. Generally, this involves inserting the DNA molecule into an

expression system to which the DNA molecule is heterologous (i.e. not normally present). The heterologous DNA molecule is inserted into the expression system or vector in proper sense orientation and correct reading frame. The vector contains the necessary elements for the transcription and translation of the inserted protein-coding sequences.

U.S. Patent No. 4,237,224 to Cohen and Boyer, which is hereby incorporated by reference in its entirety, describes the production of expression systems in the form of recombinant plasmids using restriction enzyme cleavage and ligation with DNA ligase. These recombinant plasmids are then introduced by means of transformation and replicated in unicellular cultures including prokaryotic organisms and eukaryotic cells grown in tissue culture.

Recombinant genes may also be introduced into viruses, such as vaccina virus. Recombinant viruses can be generated by transfection of plasmids into cells infected with virus.

Suitable vectors include, but are not limited to, the following viral vectors such as lambda vector system gt11, gt WES.tB, Charon 4, and plasmid vectors such as pBR322, pBR325, pACYC177, pACYC1084, pUC8, pUC9, pUC18, pUC19, pLG339, pR290, pKC37, pKC101, SV 40, pBluescript II SK +/- or KS +/- (see "Stratagene Cloning Systems" Catalog (1993) from Stratagene, La Jolla, Calif, which is hereby incorporated by reference in its entirety), pQE, pIH821, pGEX, pET series (see F.W. Studier et. al., "Use of T7 RNA Polymerase to Direct Expression of Cloned Genes," Gene Expression Technology vol. 185 (1990), which is hereby incorporated by reference in its entirety), and any derivatives thereof. Recombinant molecules can be introduced into cells via transformation, particularly transduction, conjugation, mobilization, or electroporation. The DNA sequences are cloned into the vector using standard cloning procedures in the art, as described by Sambrook et al., Molecular Cloning: A Laboratory Manual, Cold Springs Laboratory, Cold Springs Harbor, New York (1989), which is hereby incorporated by reference in its entirety.

A variety of host-vector systems may be utilized to express the protein-encoding sequence(s). Primarily, the vector system must be compatible with the host cell used. Host-vector systems include but are not limited to the following: bacteria transformed with bacteriophage DNA, plasmid DNA, or cosmid DNA; microorganisms such as yeast containing yeast vectors; mammalian cell systems

infected with virus (e.g., vaccinia virus, adenovirus, etc.); insect cell systems infected with virus (e.g., baculovirus); and plant cells infected by bacteria. The expression elements of these vectors vary in their strength and specificities. Depending upon the host-vector system utilized, any one of a number of suitable transcription and translation elements can be used.

Different genetic signals and processing events control many levels of gene expression (e.g., DNA transcription and messenger RNA (mRNA) translation).

Transcription of DNA is dependent upon the presence of a promoter which is a DNA sequence that directs the binding of RNA polymerase and thereby promotes mRNA synthesis. The DNA sequences of eukaryotic promoters differ from those of prokaryotic promoters. Furthermore, eukaryotic promoters and accompanying genetic signals may not be recognized in or may not function in a prokaryotic system, and, further, prokaryotic promoters are not recognized and do not function in eukaryotic cells.

Similarly, translation of mRNA in prokaryotes depends upon the presence of the proper prokaryotic signals which differ from those of eukaryotes. Efficient translation of mRNA in prokaryotes requires a ribosome binding site called the Shine-Dalgarno ("SD") sequence on the mRNA. This sequence is a short nucleotide sequence of mRNA that is located before the start codon, usually AUG, which encodes the amino-terminal methionine of the protein. The SD sequences are complementary to the 3'-end of the 16S rRNA (ribosomal RNA) and probably promote binding of mRNA to ribosomes by duplexing with the rRNA to allow correct positioning of the ribosome. For a review on maximizing gene expression, see Roberts and Lauer, Methods in Enzymology, 68:473 (1979), which is hereby incorporated by reference in its entirety.

Promoters vary in their "strength" (i.e. their ability to promote transcription). For the purposes of expressing a cloned gene, it is desirable to use strong promoters in order to obtain a high level of transcription and, hence, expression of the gene. Depending upon the host cell system utilized, any one of a number of suitable promoters may be used. For instance, when cloning in *E. coli*, its bacteriophages, or plasmids, promoters such as the T7 phage promoter, *lac* promoter, *trp* promoter, *recA* promoter, ribosomal RNA promoter, the P_R and P_L promoters of coliphage lambda and others, including but not limited, to *lacUV5*, *ompF*, *bla*, *lpp*,

and the like, may be used to direct high levels of transcription of adjacent DNA segments. Additionally, a hybrid *trp-lacUV5* (*tac*) promoter or other *E. coli* promoters produced by recombinant DNA or other synthetic DNA techniques may be used to provide for transcription of the inserted gene.

5 Bacterial host cell strains and expression vectors may be chosen which inhibit the action of the promoter unless specifically induced. In certain operations, the addition of specific inducers is necessary for efficient transcription of the inserted DNA. For example, the *lac* operon is induced by the addition of lactose or IPTG (isopropylthio-beta-D-galactoside). A variety of other operons, such as *trp*, *pro*, etc.,
10 are under different controls.

Specific initiation signals are also required for efficient gene transcription and translation in prokaryotic cells. These transcription and translation initiation signals may vary in "strength" as measured by the quantity of gene specific messenger RNA and protein synthesized, respectively. The DNA expression vector,
15 which contains a promoter, may also contain any combination of various "strong" transcription and/or translation initiation signals. For instance, efficient translation in *E. coli* requires an SD sequence about 7-9 bases 5' to the initiation codon ("ATG") to provide a ribosome binding site. Thus, any SD-ATG combination that can be utilized by host cell ribosomes may be employed. Such combinations include but are not
20 limited to the SD-ATG combination from the *cro* gene or the *N* gene of coliphage lambda, or from the *E. coli* tryptophan E, D, C, B or A genes. Additionally, any SD-ATG combination produced by recombinant DNA or other techniques involving incorporation of synthetic nucleotides may be used.

Once the isolated DNA molecule encoding the hypersensitive response
25 elicitor polypeptide or protein has been cloned into an expression system, it is ready to be incorporated into a host cell. Such incorporation can be carried out by the various forms of transformation noted above, depending upon the vector/host cell system. Suitable host cells include, but are not limited to, bacteria, virus, yeast, mammalian cells, insect, plant, and the like.

30 Because it is desirable for recombinant host cells to secrete the hypersensitive response elicitor protein or polypeptide, it is preferable that the host cell also be transformed with a type III secretion system in accordance with Ham et al., "A Cloned *Erwinia chrysanthemi* Hrp (Type III Protein Secretion) System

Functions in *Escherichia coli* to Deliver *Pseudomonas syringae* Avr Signals to Plant Cells and Secrete Avr Proteins in Culture," Microbiol. 95:10206-10211 (1998), which is hereby incorporated by reference in its entirety.

Isolation of the hypersensitive response elicitor protein or polypeptide
5 from the host cell or growth medium can be carried out as described above.

The methods of the present invention can be performed by treating the ornamental plant or a cutting removed therefrom.

Before removal of a cutting, suitable application methods include, without limitation, high or low pressure spraying of the entire plant. After removal of
10 a cutting, suitable application methods include, without limitation, low or high pressure spraying, coating, or immersion. Other suitable application procedures (both pre- and post-cutting) can be envisioned by those skilled in the art provided they are able to effect contact of the hypersensitive response elicitor protein or polypeptide with the cutting. Once treated, the cuttings can be handled, packed, shipped, and
15 processed using conventional procedures to deliver the cuttings to distributors or end-consumers.

The hypersensitive response elicitor polypeptide or protein can be applied to cuttings in accordance with the present invention alone or in a mixture with other materials. Alternatively, the hypersensitive response elicitor polypeptide or
20 protein can be applied separately to cuttings with other materials being applied at different times.

A composition suitable for treating ornamental plants or cuttings therefrom in accordance with the application embodiment of the present invention contains an isolated hypersensitive response elicitor polypeptide or protein in a
25 carrier. Suitable carriers include water, aqueous solutions, slurries, or dry powders. The composition preferably contains greater than about 500 nM hypersensitive response elicitor polypeptide or protein, although greater or lesser amounts of the hypersensitive response elicitor polypeptide or protein depending on the rate of composition application and efficacy of different hypersensitive response elicitor
30 proteins or polypeptides.

Although not required, this composition may contain additional additives including fertilizer, insecticide, fungicide, nematocide, and mixtures thereof.

Suitable fertilizers include $(\text{NH}_4)_2\text{NO}_3$. An example of a suitable insecticide is Malathion. Useful fungicides include Captan.

Other suitable additives include buffering agents, wetting agents, coating agents, and ripening agents. These materials can be used either to facilitate the process of the present invention or to provide additive benefits to inhibit desiccation or promote flowering.

As indicated above, one embodiment of the present invention involves treating ornamental plants or their cuttings with an isolated hypersensitive response elicitor protein or polypeptide. The hypersensitive response elicitor protein or polypeptide can be isolated from its natural source (e.g., *Erwinia amylovora*, *Pseudomonas syringae*, etc.) or from recombinant source transformed with a DNA molecule encoding the protein or polypeptide.

Another aspect of the present invention relates to a DNA construct as well as host cells, expression systems, and transgenic plants which contain the heterologous DNA construct.

The DNA construct includes a DNA molecule encoding a hypersensitive response elicitor protein or polypeptide, a plant-expressible promoter operably coupled 5' to the DNA molecule and which is effective to transcribe the DNA molecule in the tissues of cuttings, and a 3' regulatory region operably coupled to the DNA molecule. Expression of the DNA molecule in such tissues imparts to a cutting resistance against desiccation.

Expression of such heterologous DNA molecules requires a suitable promoter which is operable in plant tissues. In some embodiments of the present invention, it may be desirable for the heterologous DNA molecule to be expressed in many, if not all, tissues. Such promoters yield constitutive expression of coding sequences under their regulatory control. Exemplary constitutive promoters include, without limitation, the nopaline synthase promoter (Fraley et al., Proc. Natl. Acad. Sci. USA 80:4803-4807 (1983), which is hereby incorporated by reference in its entirety) and the cauliflower mosaic virus 35S promoter (O'Dell et al., "Identification of DNA Sequences Required for Activity of the Cauliflower Mosaic Virus 35S Promoter," Nature, 313(6005):810-812 (1985), which is hereby incorporated by reference in its entirety). Other constitutive plant promoters are continuously being identified and can be used in accordance with the present invention.

While constitutive expression is generally suitable for expression of the DNA molecule, it should be apparent to those of skill in the art that temporally or tissue regulated expression may also be desirable, in which case any regulated promoter can be selected to achieve the desired expression. Typically, the temporally or tissue regulated promoters will be used in connection with the DNA molecule that are expressed at only certain stages of development or only in certain tissues.

In another embodiment of the present invention, expression of the heterologous DNA molecule is directed in a tissue-specific manner or environmentally-regulated manner (i.e., inducible promoters). Tissue-specific promoters under developmental control include promoters that initiate transcription only in certain tissues.

Promoters useful for expression in leaf tissue include the Rubisco small subunit promoter.

Promoters useful for expression in flower tissues include the 5-enolpyruvylshikimate-3-phosphate synthase promoter (Benfy, et al., "Sequence Requirements of the 5-enolpyruvylshikimate-3-phosphate Synthase 5'-Upstream Region for Tissue-Specific Expression in Flowers and Seedlings," The Plant Cell 2:849-856 (1990), which is hereby incorporated by reference in its entirety) and the tomato PG β -subunit promoter (U.S. Patent No. 6,127,179 to DellaPenna et al., which is hereby incorporated by reference).

Examples of environmental conditions that may affect transcription by inducible promoters include anaerobic conditions, elevated temperature, or the presence of light. In some plants, it may also be desirable to use promoters which are responsive to pathogen infiltration or stress. For example, it may be desirable to limit expression of the protein or polypeptide in response to infection by a particular pathogen of the plant. One example of a pathogen-inducible promoter is the *gstI* promoter from potato, which is described in U.S. Patent Nos. 5,750,874 and 5,723,760 to Strittmayer et al., each of which is hereby incorporated by reference in its entirety.

Expression of the DNA molecule in isolated plant cells or tissue or whole plants also utilizes appropriate transcription termination and polyadenylation of mRNA. Any 3' regulatory region suitable for use in plant cells or tissue can be operably linked to the first and second DNA molecules. A number of 3' regulatory

regions are known to be operable in plants. Exemplary 3' regulatory regions include, without limitation, the nopaline synthase 3' regulatory region (Fraley, et al., "Expression of Bacterial Genes in Plant Cells," Proc. Nat'l. Acad. Sci. USA, 80:4803-4807 (1983), which is hereby incorporated by reference in its entirety) and the
5 cauliflower mosaic virus 3' regulatory region (Odell, et al., "Identification of DNA Sequences Required for Activity of the Cauliflower Mosaic Virus 35S Promoter," Nature, 313(6005):810-812 (1985), which is hereby incorporated by reference in its entirety).

The promoter and a 3' regulatory region can readily be ligated to the
10 DNA molecule using well known molecular cloning techniques described in Sambrook et al., Molecular Cloning: A Laboratory Manual, Second Edition, Cold Spring Harbor Press, NY (1989), which is hereby incorporated by reference in its entirety.

One approach to transforming plant cells with a DNA molecule of the
15 present invention is particle bombardment (also known as biolistic transformation) of the host cell. This can be accomplished in one of several ways. The first involves propelling inert or biologically active particles at cells. This technique is disclosed in U.S. Patent Nos. 4,945,050, 5,036,006, and 5,100,792, all to Sanford, et al., each of which is hereby incorporated by reference in its entirety. Generally, this procedure
20 involves propelling inert or biologically active particles at the cells under conditions effective to penetrate the outer surface of the cell and to be incorporated within the interior thereof. When inert particles are utilized, the vector can be introduced into the cell by coating the particles with the vector containing the heterologous DNA. Alternatively, the target cell can be surrounded by the vector so that the vector is
25 carried into the cell by the wake of the particle. Biologically active particles (e.g., dried bacterial cells containing the vector and heterologous DNA) can also be propelled into plant cells. Other variations of particle bombardment, now known or hereafter developed, can also be used.

Another method of introducing the DNA molecule into plant cells is
30 fusion of protoplasts with other entities, either minicells, cells, lysosomes, or other fusible lipid-surfaced bodies that contain the DNA molecule. Fraley, et al., Proc. Natl. Acad. Sci. USA, 79:1859-63 (1982), which is hereby incorporated by reference in its entirety.

The DNA molecule may also be introduced into the plant cells by electroporation. Fromm, et al., Proc. Natl. Acad. Sci. USA, 82:5824 (1985), which is hereby incorporated by reference in its entirety. In this technique, plant protoplasts are electroporated in the presence of plasmids containing the DNA molecule.

- 5 Electrical impulses of high field strength reversibly permeabilize biomembranes allowing the introduction of the plasmids. Electroporated plant protoplasts reform the cell wall, divide, and regenerate.

- Another method of introducing the DNA molecule into plant cells is to infect a plant cell with *Agrobacterium tumefaciens* or *Agrobacterium rhizogenes*
10 previously transformed with the DNA molecule. Under appropriate conditions known in the art, the transformed plant cells are grown to form shoots or roots, and develop further into plants. Generally, this procedure involves inoculating the plant tissue with a suspension of bacteria and incubating the tissue for 48 to 72 hours on regeneration medium without antibiotics at 25-28°C.

- 15 *Agrobacterium* is a representative genus of the Gram-negative family Rhizobiaceae. Its species are responsible for crown gall (*A. tumefaciens*) and hairy root disease (*A. rhizogenes*). The plant cells in crown gall tumors and hairy roots are induced to produce amino acid derivatives known as opines, which are catabolized only by the bacteria. The bacterial genes responsible for expression of opines are a
20 convenient source of control elements for chimeric expression cassettes. In addition, assaying for the presence of opines can be used to identify transformed tissue.

- Heterologous genetic sequences such as a DNA molecule a hypersensitive response elicitor protein or polypeptide can be introduced into appropriate plant cells by means of the Ti plasmid of *A. tumefaciens* or the Ri plasmid
25 of *A. rhizogenes*. The Ti or Ri plasmid is transmitted to plant cells on infection by *Agrobacterium* and is stably integrated into the plant genome. Schell, J., Science, 237:1176-83 (1987), which is hereby incorporated by reference in its entirety.

Plant tissue suitable for transformation include leaf tissue, root tissue, meristems, zygotic and somatic embryos, and anthers.

- 30 After transformation, the transformed plant cells can be selected and regenerated.

Preferably, transformed cells are first identified using, e.g., a selection marker simultaneously introduced into the host cells along with the DNA molecule of

the present invention. Suitable selection markers include, without limitation, markers coding for antibiotic resistance, such as kanamycin resistance (Fraley, et al., Proc. Natl. Acad. Sci. USA, 80:4803-4807 (1983), which is hereby incorporated by reference in its entirety). A number of antibiotic-resistance markers are known in the art and other are continually being identified. Any known antibiotic-resistance marker can be used to transform and select transformed host cells in accordance with the present invention. Cells or tissues are grown on a selection media containing an antibiotic, whereby generally only those transformants expressing the antibiotic resistance marker continue to grow.

Once a recombinant plant cell or tissue has been obtained, it is possible to regenerate a full-grown plant therefrom. Thus, another aspect of the present invention relates to a transgenic ornamental plant that includes a heterologous DNA molecule encoding a hypersensitive response elicitor protein or polypeptide, wherein the heterologous DNA molecule is under control of a promoter that induces transcription of the DNA molecule in tissues of cuttings. Preferably, the DNA molecule is stably inserted into the genome of the transgenic plant of the present invention.

Plant regeneration from cultured protoplasts is described in Evans, et al., Handbook of Plant Cell Cultures, Vol. 1: (MacMillan Publishing Co., New York, 1983); and Vasil I.R. (ed.), Cell Culture and Somatic Cell Genetics is hereby incorporated by reference in its entirety.

It is known that practically all plants can be regenerated from cultured cells or tissues, including both monocots and dicots.

Means for regeneration vary from species to species of plants, but generally a suspension of transformed protoplasts or a petri plate containing transformed explants is first provided. Callus tissue is formed and shoots may be induced from callus and subsequently rooted. Alternatively, embryo formation can be induced in the callus tissue. These embryos germinate as natural embryos to form plants. The culture media will generally contain various amino acids and hormones, such as auxin and cytokinins. It is also advantageous to add glutamic acid and proline to the medium, especially for such species as corn and alfalfa. Efficient regeneration will depend on the medium, on the genotype, and on the history of the culture. If

these three variables are controlled, then regeneration is usually reproducible and repeatable.

After the DNA molecule encoding the hypersensitive response elicitor protein or polypeptide is stably incorporated in transgenic plants, it can be transferred
5 to other plants by sexual crossing or by preparing cultivars. With respect to sexual crossing, any of a number of standard breeding techniques can be used depending upon the species to be crossed. Cultivars can be propagated in accord with common agricultural procedures known to those in the field.

With respect to desiccation, complete protection against desiccation
10 may not be conferred, but the severity of desiccation can be reduced. Desiccation protection inevitably will depend, at least to some extent, on other conditions such as storage temperatures, light exposure, etc. However, this method of controlling desiccation has the potential for eliminating some other treatments (i.e., additives to water, thermal regulation, etc.) which may contribute to reduced costs or, at least,
15 substantially no increase in costs. Moreover, by controlling desiccation, it is also possible to enhance the longevity of flower blooms.

The methods of the present invention can be utilized to treat a wide variety of ornamental plants to control desiccation of cuttings removed therefrom as well as enhance the longevity of flowers. Ornamental plants can be either monocots
20 or dicots. Cuttings include stems, leaves, flowers, or combinations thereof.

In addition to treatment with hypersensitive response elicitor proteins or polypeptides, as well as transgenic expression thereof in tissues of cuttings, cuttings or ornamental plants (transgenic or otherwise) can also be treated with ethylene action inhibitors of the types disclosed in U.S. Patent No. 6,194,350 to
25 Sisler, U.S. Patent No. 6,153,559 to Heiman, and U.S. Patent No. 5,518,988 to Sisler et al., each of which is hereby incorporated by reference in its entirety. Such treatment can occur before harvest, after harvest, or both. One commercially available ethylene-action inhibitor is EthylBloc® (1-methylcyclopropene, available from AgroFresh Inc. and Floralife Inc.).

EXAMPLES

The following examples are intended to illustrate, but by no means are intended to limit, the scope of the present invention as set forth in the appended
5 claims.

Example 1- Increased Flower Quality and Longevity of Roses from Postharvest Application of EBC-151 (Messenger®)

Mature rose plants were treated with Messenger® (coded as EBC-151)
10 by foliar sprays and postharvest treatment to improve flower quality and longevity. The trial was established in a commercial rose greenhouse in Villa Guerrero, Mexico. The rose variety in this trial was *Vega*. Individual plot beds contained approximately 44 mature plants arranged in two rows; each plot was replicated 4 times and measured 80 cm wide by 15.4 m long. EBC-151 treatments were applied with a CO₂-powered
15 backpack sprayer calibrated to deliver 430 l/Ha at 90 psi. Treatment rates and timings in this trial are shown in Table 1 below.

Table 1: Application rates and treatment schedule for EBC-151 to *Vega* roses

Treatment	EBC-151 Application Rate	Treatment Details
1	250 g/Ha	8 applications at approximately 14-d intervals
2	250 g/Ha + 3.33 g/L postharvest spray	8 applications at approximately 14-d intervals followed by a postharvest spray to 10 commercially-harvested flower/stems within 1 hour of cutting
3	150 g Ha + 350 g/Ha	150 g/Ha applied 5 times followed by 350 g/Ha applied 3 times at the same 14-d schedule, no postharvest application
4	150 g/Ha + 350 g/Ha + 3.33 g/L postharvest spray	150 g/Ha applied 5 times followed by 350 g/Ha applied 3 times at the same 14-d schedule followed by a postharvest spray to 10 commercially-harvested flower/stems within 1 hour of cutting
5	3.33 g/L postharvest spray only	Postharvest spray only to 10 commercially-harvested flower/stems within 1 hour of cutting
6	N/a	Untreated with EBC-151

Preharvest applications of each EBC-151 treatment were repeated at
20 approximately 14-d intervals. After the fifth preharvest application, 10 mature flower/stems were randomly selected from each treatment and evaluated. Treatment effects were evaluated on cut flowers by assessing the number of open flowers and the

number of "straight" stems on each flower/stem. An "open" flower was determined to conform to commercial standards for sale by having flower petals extended. Flower petals judged as partially extended were rated as "not open". Straight stems were evaluated as conforming to commercial standard of acceptability for sale.

- 5 Results for this evaluation are shown in Table 2 below. No postharvest applications of EBC-151 were made to flower/stems harvested after the fifth application of EBC-151.

Table 2: Response of cut *Vega* roses to treatment with EBC-151 (five applications only)

Treatment	Number of Flowers	Number of "Open" Flowers	Percent "open" Flowers	Number of Flowers with "Straight" Stems
1	10	10	100	10
3	10	2	20	6
6	10	1	10	4

- 10 Additional preharvest treatments continued with three more applications (for a total of eight applications). Following the eighth application, an additional 10 mature flower/stems were then randomly selected from each treatment and evaluated in the same manner as had been done after the fifth application. Immediately after cutting (within 1 hour) a single postharvest treatment of EBC-151
- 15 was applied at the rate of 3.33 g/L (100 ppm a.i.) to the cut flower/stems harvest from Treatments 2, 4 and 5. The postharvest spray was applied by completely misting each flower/stem with the EBC-151 solution. Sixteen days after postharvest treatment, the number of open flowers and number of flowers with "straight" stems were determined for each treatment. Results for this evaluation are shown in Table 3 below.

20

Table 3: Response of cut *Vega* roses to treatment with EBC-151 (eight preharvest and one postharvest application)

Treatment	Number of Flowers	Number of "Open" Flowers	Percent "open" Flowers	Number of Flowers with "Straight" Stems
1	10	9	90	8
2	10	10	100	8
3	10	9	90	9
4	10	10	100	9
5	10	3	30	1
6	10	2	20	2

Visual observations of cut roses 16 days after postharvest treatment were made for treatments that received postharvest applications of EBC-151. Roses that had been treated with the postharvest application of EBC-151 appeared to have substantially greater longevity than those that had not received the postharvest treatment (Figures 1-3).

Results of this trial demonstrated a treatment effect for application of EBC-151 (Messenger[®]) to roses. The effect was seen in a substantially greater increase in the number of open flowers at harvest. This effect is of significant commercial benefit to rose growers. In addition, the postharvest application of EBC-151 to cut roses resulted in substantially extending the "shelf life" of the cut roses.

Although the invention has been described in detail for the purpose of illustration, it is understood that such detail is solely for that purpose, and variations can be made therein by those skilled in the art without departing from the spirit and scope of the invention which is defined by the following claims.

WHAT IS CLAIMED:

1. A method of inhibiting desiccation of cuttings from ornamental plants comprising:
treating an ornamental plant with a hypersensitive response elicitor protein or polypeptide under conditions effective to inhibit desiccation of a cutting from the ornamental plant after the cutting is removed from the ornamental plant.
2. The method of claim 1, wherein said treating comprises topically applying the hypersensitive response elicitor protein or polypeptide to the ornamental plant.
3. The method of claim 1, wherein the hypersensitive response elicitor protein or polypeptide is derived from a plant pathogen.
4. The method of claim 3, wherein the plant pathogen is selected from the group consisting of *Erwinia*, *Pseudomonas*, *Ralstonia*, *Xanthomonas*, *Clavibacter*, and *Phytophthora*.
5. The method of claim 1, wherein the ornamental plant is a monocot or a dicot.
6. The method of claim 1 further comprising:
removing a cutting from the treated ornamental plant and
applying a hypersensitive response elicitor to the removed cutting.
7. The method of claim 1, wherein the cutting comprises a stem, a leaf, a flower, or combinations thereof.

8. A cutting which has been removed from an ornamental plant treated with a hypersensitive response elicitor protein or polypeptide, wherein the cutting is characterized by greater resistance to desiccation as compared to a cutting removed from an untreated ornamental plant.

9. The cutting according to claim 8, wherein the cutting comprises a stem, a leaf, a flower, or combinations thereof.

10. The cutting of claim 8, wherein the hypersensitive response elicitor protein or polypeptide is derived from a plant pathogen.

11. The cutting of claim 10, wherein the plant pathogen is selected from the group consisting of *Erwinia*, *Pseudomonas*, *Ralstonia*, *Xanthomonas*, *Clavibacter*, and *Phytophthora*.

12. The cutting of claim 8, wherein the ornamental plant is a monocot or a dicot.

13. A method of promoting early flowering of an ornamental plant comprising:

treating an ornamental plant with a hypersensitive response elicitor protein or polypeptide under conditions effective to promote early flowering of the ornamental plant.

14. The method of claim 13, wherein said treating comprises topically applying the hypersensitive response elicitor to the ornamental plant.

15. The method of claim 13, wherein the hypersensitive response elicitor protein or polypeptide is derived from a plant pathogen.

16. The method of claim 15, wherein the plant pathogen is selected from the group consisting of *Erwinia*, *Pseudomonas*, *Ralstonia*, *Xanthomonas*, *Clavibacter*, and *Phytophthora*.

17. The method of claim 13, wherein the ornamental plant is a monocot or a dicot.
18. A method of harvesting a cutting from an ornamental plant comprising:
treating an ornamental plant with a hypersensitive response elicitor protein or polypeptide and
harvesting a cutting from the treated ornamental plant.
19. The method of claim 18, wherein said treating comprises topically applying the hypersensitive response elicitor protein or polypeptide to the ornamental plant.
20. The method of claim 18, wherein the hypersensitive response elicitor protein or polypeptide is derived from a plant pathogen.
21. The method of claim 20, wherein the plant pathogen is selected from the group consisting of *Erwinia*, *Pseudomonas*, *Ralstonia*, *Xanthomonas*, *Clavibacter*, and *Phytophthora*.
22. The method of claim 18, wherein the ornamental plant is a monocot or a dicot.
23. The method of claim 18 further comprising:
applying a hypersensitive response elicitor protein or polypeptide to the harvested cutting.
24. The method of claim 18, wherein the cutting comprises a stem, a leaf, a flower, or combinations thereof.

25. A method of harvesting a cutting from an ornamental plant comprising:

harvesting a cutting from an ornamental plant and
treating the harvested cutting with a hypersensitive response
elicitor protein or polypeptide.

26. The method of claim 25, wherein said treating comprises
topically applying the hypersensitive response elicitor protein or polypeptide to the
cutting.

27. The method of claim 25, wherein the hypersensitive response
elicitor protein or polypeptide is derived from a plant pathogen.

28. The method of claim 27, wherein the plant pathogen is selected
from the group consisting of *Erwinia*, *Pseudomonas*, *Ralstonia*, *Xanthomonas*,
Clavibacter, and *Phytophthora*.

29. The method of claim 25, wherein the ornamental plant is a
monocot or a dicot.

30. The method of claim 25, wherein the cutting comprises a stem,
a leaf, a flower, or combinations thereof.

31. A method of inhibiting desiccation of cuttings from ornamental
plants comprising:

removing a cutting from an ornamental plant and
treating the removed cutting with a hypersensitive response
elicitor protein or polypeptide under conditions effective to inhibit desiccation of the
removed cutting.

32. The method of claim 31, wherein said treating comprises
topically applying the hypersensitive response elicitor protein or polypeptide to the
cutting.

33. The method of claim 31, wherein the hypersensitive response elicitor protein or polypeptide is derived from a plant pathogen.

34. The method of claim 33, wherein the plant pathogen is selected from the group consisting of *Erwinia*, *Pseudomonas*, *Ralstonia*, *Xanthomonas*, *Clavibacter*, and *Phytophthora*.

35. The method of claim 31, wherein the ornamental plant is a monocot or a dicot.

36. The method of claim 31, wherein the cutting comprises a stem, a leaf, a flower, or combinations thereof.

37. A cutting which has been removed from an ornamental plant, wherein the cutting has been treated with a hypersensitive response elicitor protein or polypeptide and wherein the cutting is characterized by greater resistance to desiccation as compared to an untreated cutting removed from the ornamental plant.

38. The cutting according to claim 37, wherein the cutting comprises a stem, a leaf, a flower, or combinations thereof.

39. The cutting of claim 37, wherein the hypersensitive response elicitor protein or polypeptide is derived from a plant pathogen.

40. The cutting of claim 39, wherein the plant pathogen is selected from the group consisting of *Erwinia*, *Pseudomonas*, *Ralstonia*, *Xanthomonas*, *Clavibacter*, and *Phytophthora*.

41. The cutting of claim 37, wherein the ornamental plant is a monocot or a dicot.

42. A method of inhibiting desiccation of cuttings from ornamental plants comprising:

providing a transgenic ornamental plant or plant seed transformed with a DNA molecule encoding a hypersensitive response elicitor polypeptide or protein and

growing the transgenic ornamental plant or transgenic ornamental plant produced from the transgenic ornamental plant seed under conditions effective to inhibit desiccation in a cutting removed from the transgenic plant.

43. The method of claim 42, wherein the hypersensitive response elicitor protein or polypeptide is derived from a plant pathogen.

44. The method of claim 43, wherein the plant pathogen is selected from the group consisting of *Erwinia*, *Pseudomonas*, *Ralstonia*, *Xanthomonas*, *Clavibacter*, and *Phytophthora*.

45. The method of claim 42, wherein the transgenic ornamental plant is a monocot or a dicot.

46. The method of claim 42, wherein the cutting is a stem, a leaf, a flower, or combinations thereof.

47. The method of claim 42 further comprising:
removing a cutting from the transgenic ornamental plant and
applying a hypersensitive response elicitor protein or polypeptide to the removed cutting.

48. The method of claim 42, wherein the hypersensitive response elicitor protein or polypeptide is expressed in tissues of the cutting.

49. A method of promoting early flowering of an ornamental plant comprising:

providing a transgenic ornamental plant or plant seed transformed with a DNA molecule encoding a hypersensitive response elicitor polypeptide or protein and

growing the transgenic ornamental plant or transgenic ornamental plant produced from the transgenic ornamental plant seed under conditions effective to promote early flowering of the transgenic ornamental plant.

50. The method of claim 49, wherein the hypersensitive response elicitor protein or polypeptide is derived from a plant pathogen.

51. The method of claim 50, wherein the plant pathogen is selected from the group consisting of *Erwinia*, *Pseudomonas*, *Ralstonia*, *Xanthomonas*, *Clavibacter*, and *Phytophthora*.

52. The method of claim 49, wherein the transgenic ornamental plant is a monocot or a dicot.

53. The method of claim 49, wherein the cutting is a stem, a leaf, a flower, or combinations thereof.

54. The method of claim 49, wherein the hypersensitive response elicitor protein or polypeptide is expressed in flower tissues.

55. A method of harvesting a cutting from an ornamental plant comprising:

providing a transgenic ornamental plant or plant seed transformed with a DNA molecule encoding a hypersensitive response elicitor polypeptide or protein;

growing the transgenic ornamental plant or transgenic ornamental plant produced from the transgenic ornamental plant seed under conditions; and

harvesting a cutting from the grown transgenic ornamental plant, wherein the cutting exhibits a reduced susceptibility to desiccation as compared to cuttings removed from non-transgenic ornamental plants.

56. The method of claim 55, wherein the hypersensitive response elicitor protein or polypeptide is derived from a plant pathogen.

57. The method of claim 56, wherein the plant pathogen is selected from the group consisting of *Erwinia*, *Pseudomonas*, *Ralstonia*, *Xanthomonas*, *Clavibacter*, and *Phytophthora*.

58. The method of claim 55, wherein the transgenic ornamental plant is a monocot or a dicot.

59. The method of claim 55, wherein the cutting is a stem, a leaf, a flower, or combinations thereof.

60. The method of claim 55 further comprising:
applying a hypersensitive response elicitor protein or polypeptide to the harvested cutting.

61. The method of claim 55, wherein the hypersensitive response elicitor protein or polypeptide is expressed in tissues of the cutting.

62. A cutting which has been removed from a transgenic ornamental plant which expresses a heterologous hypersensitive response elicitor protein or polypeptide, wherein the cutting is characterized by greater resistance to desiccation as compared to a cutting removed from a non-transgenic ornamental plant.

63. The cutting of claim 62, wherein the cutting comprises a stem, a leaf, a flower, or combinations thereof.

64. The cutting of claim 62, wherein the hypersensitive response elicitor protein or polypeptide is derived from a plant pathogen.

65. The cutting of claim 64, wherein the plant pathogen is selected from the group consisting of *Erwinia*, *Pseudomonas*, *Ralstonia*, *Xanthomonas*, *Clavibacter*, and *Phytophthora*.

66. The cutting of claim 62, wherein the transgenic ornamental plant is a monocot or a dicot.

67. The cutting of claim 62, wherein the hypersensitive response elicitor protein or polypeptide is expressed in tissues of the cutting.

68. A method of enhancing the longevity of flower blooms on ornamental plant cuttings, the method comprising:
providing a transgenic ornamental plant or plant seed transformed with a DNA molecule encoding a hypersensitive response elicitor polypeptide or protein and
growing the transgenic ornamental plant or transgenic ornamental plant produced from the transgenic ornamental plant seed under conditions effective to enhancing the longevity of flower blooms on cuttings removed therefrom.

69. The method of claim 68, wherein the hypersensitive response elicitor protein or polypeptide is derived from a plant pathogen.

70. The method of claim 69, wherein the plant pathogen is selected from the group consisting of *Erwinia*, *Pseudomonas*, *Ralstonia*, *Xanthomonas*, *Clavibacter*, and *Phytophthora*.

71. The method of claim 68, wherein the transgenic ornamental plant is a monocot or a dicot.

72. The method of claim 68, wherein the cutting is a stem, a leaf, a flower, or combinations thereof.

73. The method of claim 68, wherein the hypersensitive response elicitor protein or polypeptide is expressed in flower tissues.

74. The method of claim 68 further comprising:
harvesting a cutting from the transgenic ornamental plant and
applying a hypersensitive response elicitor protein or
polypeptide to the harvested cutting.

75. A method of enhancing the longevity of flower blooms on ornamental plant cuttings, the method comprising:
treating an ornamental plant with a hypersensitive response
elicitor protein or polypeptide under conditions effective to enhancing the longevity
of flower blooms on cuttings removed therefrom.

76. The method of claim 75, wherein said treating comprises
topically applying the hypersensitive response elicitor to the ornamental plant.

77. The method of claim 75, wherein the hypersensitive response
elicitor protein or polypeptide is derived from a plant pathogen.

78. The method of claim 77, wherein the plant pathogen is selected
from the group consisting of *Erwinia*, *Pseudomonas*, *Ralstonia*, *Xanthomonas*,
Clavibacter, and *Phytophthora*.

79. The method of claim 75, wherein the ornamental plant is a
monocot or a dicot.

80. The method of claim 75 further comprising:
harvesting a cutting from the treated ornamental plant and
applying a hypersensitive response elicitor protein or
polypeptide to the harvested cutting.
81. A method of enhancing the longevity of flower blooms on
ornamental plant cuttings, the method comprising:
harvesting a cutting from an ornamental plant and
treating the harvested cutting with a hypersensitive response
elicitor protein or polypeptide under conditions effective to enhancing the longevity
of flower blooms on the harvested cutting.
82. The method of claim 81, wherein said treating comprises
topically applying the hypersensitive response elicitor to the ornamental plant.
83. The method of claim 81, wherein the hypersensitive response
elicitor protein or polypeptide is derived from a plant pathogen.
84. The method of claim 83, wherein the plant pathogen is selected
from the group consisting of *Erwinia*, *Pseudomonas*, *Ralstonia*, *Xanthomonas*,
Clavibacter, and *Phytophthora*.
85. The method of claim 81, wherein the ornamental plant is a
monocot or a dicot.

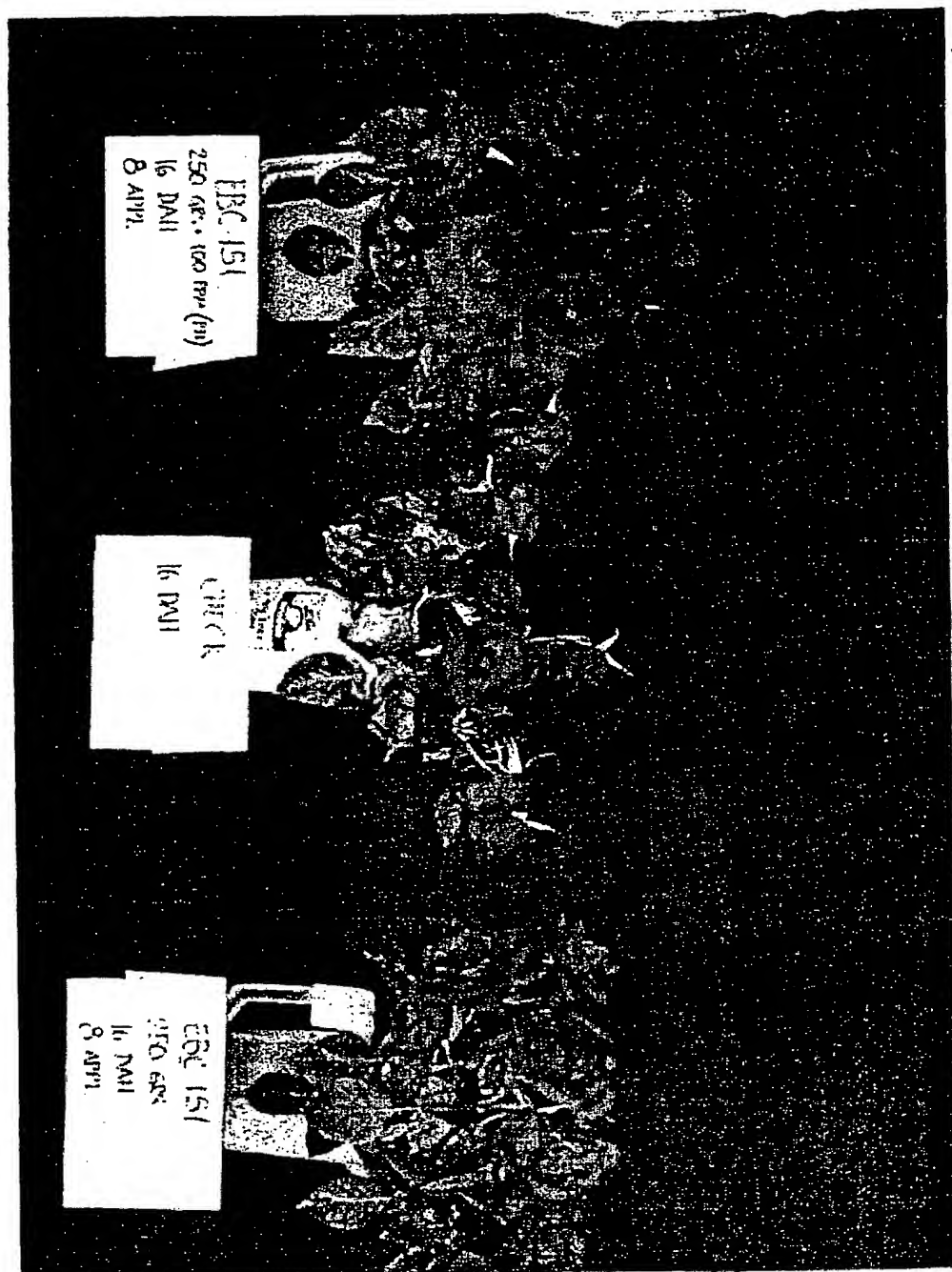


Figure 1

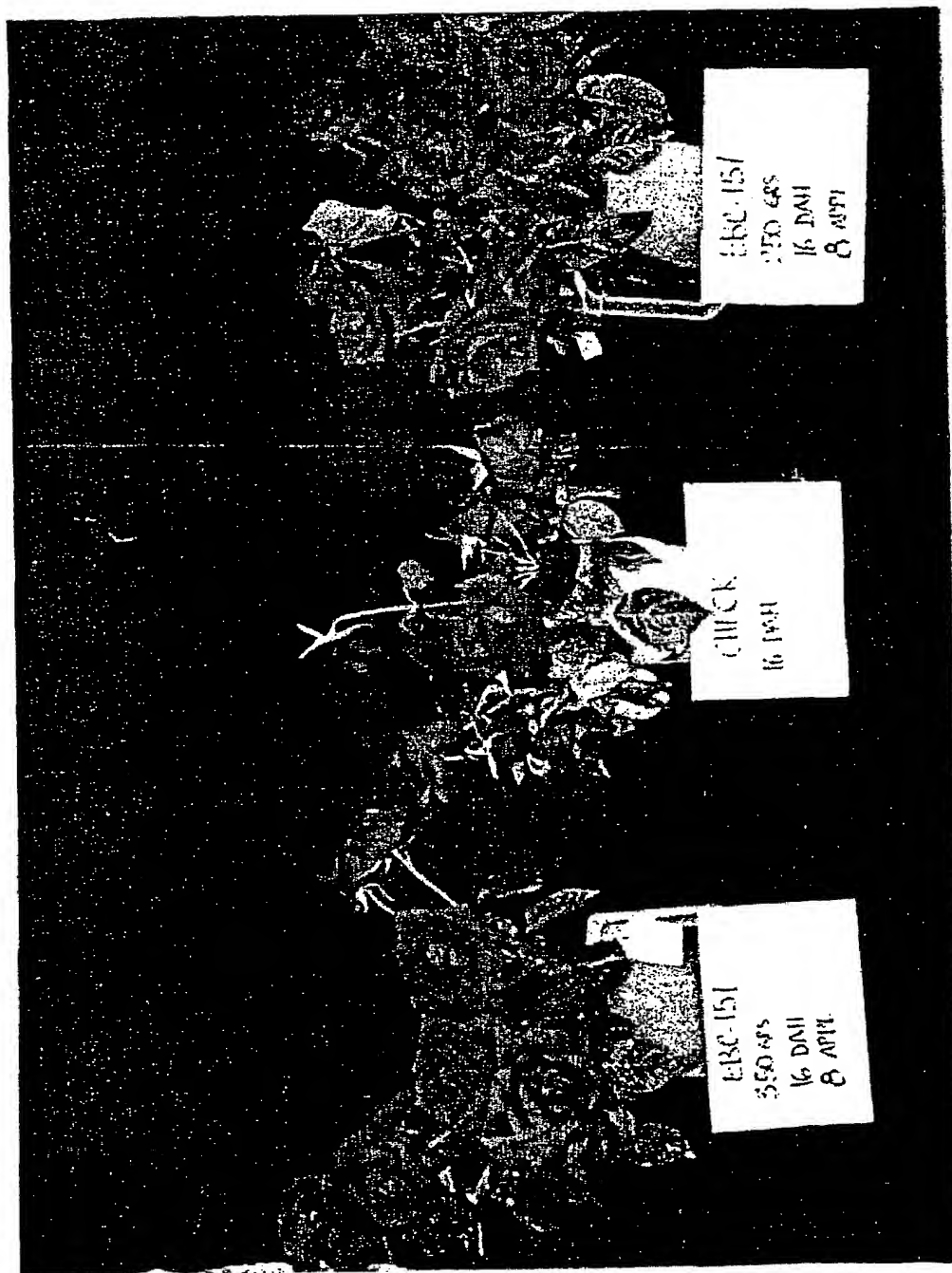


Figure 2

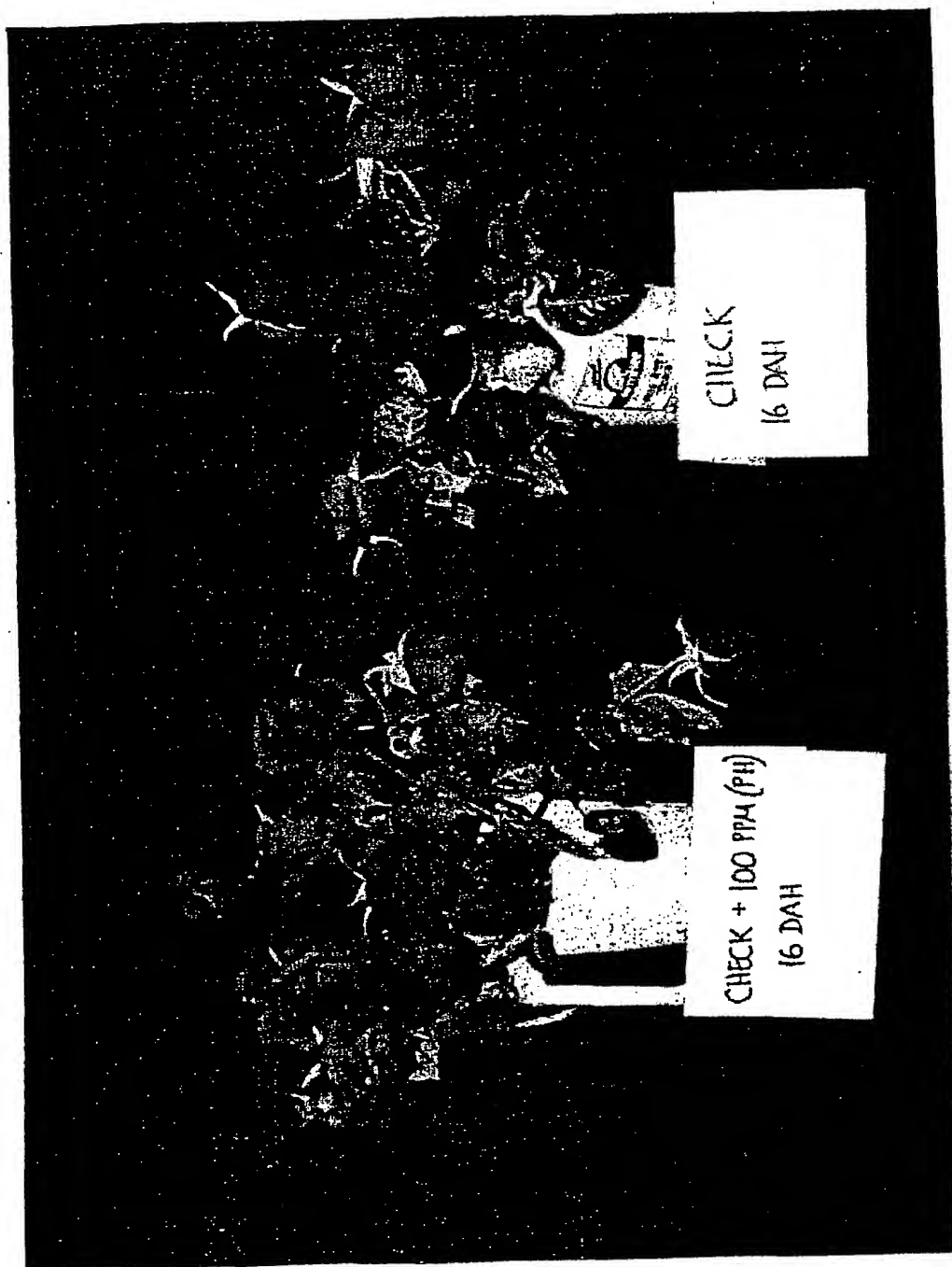


Figure 3

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aaaatagggc agtttttgcg tggatccgt ggggtgttcc ggcctgacaa tcttgagttg 2100
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<210> 3

<211> 403

<212> PRT

<213> *Erwinia amylovora*

<400> 3

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Met Ser Leu Asn Thr Ser Gly Leu Gly Ala Ser Thr Met Gln Ile Ser
1           5           10           15

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Ile Gly Gly Ala Gly Gly Asn Asn Gly Leu Leu Gly Thr Ser Arg Gln
 20 25 30
 Asn Ala Gly Leu Gly Gly Asn Ser Ala Leu Gly Leu Gly Gly Gly Asn
 35 40 45
 Gln Asn Asp Thr Val Asn Gln Leu Ala Gly Leu Leu Thr Gly Met Met
 50 55 60
 Met Met Met Ser Met Met Gly Gly Gly Gly Leu Met Gly Gly Gly Leu
 65 70 75 80
 Gly Gly Gly Leu Gly Asn Gly Leu Gly Gly Ser Gly Gly Leu Gly Glu
 85 90 95
 Gly Leu Ser Asn Ala Leu Asn Asp Met Leu Gly Gly Ser Leu Asn Thr
 100 105 110
 Leu Gly Ser Lys Gly Gly Asn Asn Thr Thr Ser Thr Thr Asn Ser Pro
 115 120 125
 Leu Asp Gln Ala Leu Gly Ile Asn Ser Thr Ser Gln Asn Asp Asp Ser
 130 135 140
 Thr Ser Gly Thr Asp Ser Thr Ser Asp Ser Ser Asp Pro Met Gln Gln
 145 150 155 160
 Leu Leu Lys Met Phe Ser Glu Ile Met Gln Ser Leu Phe Gly Asp Gly
 165 170 175
 Gln Asp Gly Thr Gln Gly Ser Ser Ser Gly Gly Lys Gln Pro Thr Glu
 180 185 190
 Gly Glu Gln Asn Ala Tyr Lys Lys Gly Val Thr Asp Ala Leu Ser Gly
 195 200 205
 Leu Met Gly Asn Gly Leu Ser Gln Leu Leu Gly Asn Gly Gly Leu Gly
 210 215 220
 Gly Gly Gln Gly Gly Asn Ala Gly Thr Gly Leu Asp Gly Ser Ser Leu
 225 230 235 240
 Gly Gly Lys Gly Leu Gln Asn Leu Ser Gly Pro Val Asp Tyr Gln Gln
 245 250 255
 Leu Gly Asn Ala Val Gly Thr Gly Ile Gly Met Lys Ala Gly Ile Gln
 260 265 270

Ala Leu Asn Asp Ile Gly Thr His Arg His Ser Ser Thr Arg Ser Phe
 275 280 285

Val Asn Lys Gly Asp Arg Ala Met Ala Lys Glu Ile Gly Gln Phe Met
 290 295 300

Asp Gln Tyr Pro Glu Val Phe Gly Lys Pro Gln Tyr Gln Lys Gly Pro
 305 310 315 320

Gly Gln Glu Val Lys Thr Asp Asp Lys Ser Trp Ala Lys Ala Leu Ser
 325 330 335

Lys Pro Asp Asp Asp Gly Met Thr Pro Ala Ser Met Glu Gln Phe Asn
 340 345 350

Lys Ala Lys Gly Met Ile Lys Arg Pro Met Ala Gly Asp Thr Gly Asn
 355 360 365

Gly Asn Leu Gln Ala Arg Gly Ala Gly Gly Ser Ser Leu Gly Ile Asp
 370 375 380

Ala Met Met Ala Gly Asp Ala Ile Asn Asn Met Ala Leu Gly Lys Leu
 385 390 395 400

Gly Ala Ala

<210> 4

<211> 1288

<212> DNA

<213> *Erwinia amylovora*

<400> 4

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 ggtggcaatt ctgcactggg gctgggcggc ggtaatcaaa atgataccgt caatcagctg 240
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 ggcggtggct taggcggtgg cttaggtaat ggcttgggtg gctcaggtgg cctgggcgaa 360
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<210> 5

<211> 447

<212> PRT

<213> *Erwinia amylovora*

<400> 5

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Ala Leu Gly Gln Gln Pro Ile Asp Arg Gln Thr Ile Glu Gln Met Ala
 35 40 45

Gln Leu Leu Ala Glu Leu Leu Lys Ser Leu Leu Ser Pro Gln Ser Gly
 50 55 60

Asn Ala Ala Thr Gly Ala Gly Gly Asn Asp Gln Thr Thr Gly Val Gly
 65 70 75 80

Asn Ala Gly Gly Leu Asn Gly Arg Lys Gly Thr Ala Gly Thr Thr Pro
 85 90 95

Gln Ser Asp Ser Gln Asn Met Leu Ser Glu Met Gly Asn Asn Gly Leu
 100 105 110

Asp Gln Ala Ile Thr Pro Asp Gly Gln Gly Gly Gly Gln Ile Gly Asp
 115 120 125

Asn Pro Leu Leu Lys Ala Met Leu Lys Leu Ile Ala Arg Met Met Asp
 130 135 140

Gly Gln Ser Asp Gln Phe Gly Gln Pro Gly Thr Gly Asn Asn Ser Ala
 145 150 155 160

Ser Ser Gly Thr Ser Ser Ser Gly Gly Ser Pro Phe Asn Asp Leu Ser

	165		170		175
Gly Gly Lys Ala Pro Ser Gly Asn Ser Pro Ser Gly Asn Tyr Ser Pro					
	180		185		190
Val Ser Thr Phe Ser Pro Pro Ser Thr Pro Thr Ser Pro Thr Ser Pro					
	195		200		205
Leu Asp Phe Pro Ser Ser Pro Thr Lys Ala Ala Gly Gly Ser Thr Pro					
	210		215		220
Val Thr Asp His Pro Asp Pro Val Gly Ser Ala Gly Ile Gly Ala Gly					
	225		230		235
Asn Ser Val Ala Phe Thr Ser Ala Gly Ala Asn Gln Thr Val Leu His					
		245		250	255
Asp Thr Ile Thr Val Lys Ala Gly Gln Val Phe Asp Gly Lys Gly Gln					
	260		265		270
Thr Phe Thr Ala Gly Ser Glu Leu Gly Asp Gly Gly Gln Ser Glu Asn					
	275		280		285
Gln Lys Pro Leu Phe Ile Leu Glu Asp Gly Ala Ser Leu Lys Asn Val					
	290		295		300
Thr Met Gly Asp Asp Gly Ala Asp Gly Ile His Leu Tyr Gly Asp Ala					
	305		310		315
Lys Ile Asp Asn Leu His Val Thr Asn Val Gly Glu Asp Ala Ile Thr					
		325		330	335
Val Lys Pro Asn Ser Ala Gly Lys Lys Ser His Val Glu Ile Thr Asn					
	340		345		350
Ser Ser Phe Glu His Ala Ser Asp Lys Ile Leu Gln Leu Asn Ala Asp					
	355		360		365
Thr Asn Leu Ser Val Asp Asn Val Lys Ala Lys Asp Phe Gly Thr Phe					
	370		375		380
Val Arg Thr Asn Gly Gly Gln Gln Gly Asn Trp Asp Leu Asn Leu Ser					
	385		390		395
His Ile Ser Ala Glu Asp Gly Lys Phe Ser Phe Val Lys Ser Asp Ser					
		405		410	415
Glu Gly Leu Asn Val Asn Thr Ser Asp Ile Ser Leu Gly Asp Val Glu					

420

425

430

Asn His Tyr Lys Val Pro Met Ser Ala Asn Leu Lys Val Ala Glu
 435 440 445

<210> 6

<211> 1344

<212> DNA

<213> *Erwinia amylovora*

<400> 6

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cggcaaacca ttgagcaaat ggctcaatta ttggcggaac tgttaaagtc actgctatcg 180
ccacaatcag gtaatgcggc aaccggagcc ggtggcaatg accagactac aggagttggg 240
aacgctggcg gcctgaacgg acgaaaaggc acagcaggaa ccaactccga gtctgacagt 300
cagaacatgc tgagtgaatg gggcaacaac gggctggatc aggccatcac gcccgatggc 360
caggcgggcg ggcagatcgg cgataatcct ttactgaaag ccatgctgaa gcttattgca 420
cgcgatgatg acggccaaaag cgatcagttt ggccaacctg gtacggggcaa caacagtgcc 480
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ccttccggca actccccttc cggcaactac tctcccgtca gtaccttctc acccccatcc 600
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<210> 7

<211> 341

<212> PRT

<213> *Pseudomonas syringae*

<400> 7

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Ala Leu Val Leu Val Arg Pro Glu Ala Glu Thr Thr Gly Ser Thr Ser
 20 25 30

Ser Lys Ala Leu Gln Glu Val Val Val Lys Leu Ala Glu Glu Leu Met
 35 40 45
 Arg Asn Gly Gln Leu Asp Asp Ser Ser Pro Leu Gly Lys Leu Leu Ala
 50 55 60
 Lys Ser Met Ala Ala Asp Gly Lys Ala Gly Gly Gly Ile Glu Asp Val
 65 70 75 80
 Ile Ala Ala Leu Asp Lys Leu Ile His Glu Lys Leu Gly Asp Asn Phe
 85 90 95
 Gly Ala Ser Ala Asp Ser Ala Ser Gly Thr Gly Gln Gln Asp Leu Met
 100 105 110
 Thr Gln Val Leu Asn Gly Leu Ala Lys Ser Met Leu Asp Asp Leu Leu
 115 120 125
 Thr Lys Gln Asp Gly Gly Thr Ser Phe Ser Glu Asp Asp Met Pro Met
 130 135 140
 Leu Asn Lys Ile Ala Gln Phe Met Asp Asp Asn Pro Ala Gln Phe Pro
 145 150 155 160
 Lys Pro Asp Ser Gly Ser Trp Val Asn Glu Leu Lys Glu Asp Asn Phe
 165 170 175
 Leu Asp Gly Asp Glu Thr Ala Ala Phe Arg Ser Ala Leu Asp Ile Ile
 180 185 190
 Gly Gln Gln Leu Gly Asn Gln Gln Ser Asp Ala Gly Ser Leu Ala Gly
 195 200 205
 Thr Gly Gly Gly Leu Gly Thr Pro Ser Ser Phe Ser Asn Asn Ser Ser
 210 215 220
 Val Met Gly Asp Pro Leu Ile Asp Ala Asn Thr Gly Pro Gly Asp Ser
 225 230 235 240
 Gly Asn Thr Arg Gly Glu Ala Gly Gln Leu Ile Gly Glu Leu Ile Asp
 245 250 255
 Arg Gly Leu Gln Ser Val Leu Ala Gly Gly Gly Leu Gly Thr Pro Val
 260 265 270
 Asn Thr Pro Gln Thr Gly Thr Ser Ala Asn Gly Gly Gln Ser Ala Gln
 275 280 285

Asp Leu Asp Gln Leu Leu Gly Gly Leu Leu Leu Lys Gly Leu Glu Ala
 290 295 300
 Thr Leu Lys Asp Ala Gly Gln Thr Gly Thr Asp Val Gln Ser Ser Ala
 305 310 315 320
 Ala Gln Ile Ala Thr Leu Leu Val Ser Thr Leu Leu Gln Gly Thr Arg
 325 330 335
 Asn Gln Ala Ala Ala
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<210> 8
 <211> 1026
 <212> DNA
 <213> *Pseudomonas syringae*

<400> 8
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 gtgaagctgg ccgaggaact gatgogcaat ggtcaactcg acgacagctc gccattggga 180
 aaactgttgg ccaagtcgat ggccgcagat ggcaaggcgg gcggcggtat tgaggatgtc 240
 atcgtctgcg tggacaagct gatccatgaa aagctcgggtg acaacttcgg cgcgtctgcg 300
 gacagcgcct cgggtaccgg acagcaggac ctgatgactc aggtgctcaa tggcctggcc 360
 aagtcgatgc tcgatgatct tctgaccaag caggatggcg ggacaagctt ctccgaagac 420
 gatatgccga tgctgaacaa gatcgcgagc ttcattggatg acaatcccgc acagtttccc 480
 aagccggact cgggctcctg ggtgaacgaa ctcaagggaag acaacttcct tgatggcgac 540
 gaaacggctg cgttccgttc ggcactcgac atcattggcc agcaactggg taatcagcag 600
 agtgacgctg gcagctctggc agggacgggt ggaggtctgg gcactccgag cagtttttcc 660
 aacaactcgt ccgtgatggg tgatccgctg atcgacgcca ataccggtcc cggtgacagc 720
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 gcctga 1026

<210> 9
 <211> 424
 <212> PRT
 <213> *Pseudomonas syringae*

<400> 9
 Met Ser Ile Gly Ile Thr Pro Arg Pro Gln Gln Thr Thr Thr Pro Leu
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Asp Phe Ser Ala Leu Ser Gly Lys Ser Pro Gln Pro Asn Thr Phe Gly
 20 25 30
 Glu Gln Asn Thr Gln Gln Ala Ile Asp Pro Ser Ala Leu Leu Phe Gly
 35 40 45
 Ser Asp Thr Gln Lys Asp Val Asn Phe Gly Thr Pro Asp Ser Thr Val
 50 55 60
 Gln Asn Pro Gln Asp Ala Ser Lys Pro Asn Asp Ser Gln Ser Asn Ile
 65 70 75 80
 Ala Lys Leu Ile Ser Ala Leu Ile Met Ser Leu Leu Gln Met Leu Thr
 85 90 95
 Asn Ser Asn Lys Lys Gln Asp Thr Asn Gln Glu Gln Pro Asp Ser Gln
 100 105 110
 Ala Pro Phe Gln Asn Asn Gly Gly Leu Gly Thr Pro Ser Ala Asp Ser
 115 120 125
 Gly Gly Gly Gly Thr Pro Asp Ala Thr Gly Gly Gly Gly Gly Asp Thr
 130 135 140
 Pro Ser Ala Thr Gly Gly Gly Gly Gly Asp Thr Pro Thr Ala Thr Gly
 145 150 155 160
 Gly Gly Gly Ser Gly Gly Gly Gly Thr Pro Thr Ala Thr Gly Gly Gly
 165 170 175
 Ser Gly Gly Thr Pro Thr Ala Thr Gly Gly Gly Glu Gly Gly Val Thr
 180 185 190
 Pro Gln Ile Thr Pro Gln Leu Ala Asn Pro Asn Arg Thr Ser Gly Thr
 195 200 205
 Gly Ser Val Ser Asp Thr Ala Gly Ser Thr Glu Gln Ala Gly Lys Ile
 210 215 220
 Asn Val Val Lys Asp Thr Ile Lys Val Gly Ala Gly Glu Val Phe Asp
 225 230 235 240
 Gly His Gly Ala Thr Phe Thr Ala Asp Lys Ser Met Gly Asn Gly Asp
 245 250 255
 Gln Gly Glu Asn Gln Lys Pro Met Phe Glu Leu Ala Glu Gly Ala Thr
 260 265 270


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<210> 10
<211> 1729
<212> DNA
<213> Pseudomonas syringae
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<400> 10						
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cctctgagtg	cggtgcggag	caataccagt	cttcctgctg	gcgtgtgcac	actgagtcgc	180
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acagtgcgat	gagatgccgg	caaaacggga	accggtcgct	gcgctttgcc	actcacttcg	300
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gagcatcggc	atcacacccc	ggcgcgaaca	gaccaccacg	ccactcgatt	tttcggcgct	480
aagcggcaag	agtccccaac	caaacacggt	cggcgagcag	aacactcagc	aagcgatcga	540
cccgagtgcg	ctgttggttcg	gcagcgacac	acagaaagac	gtcaacttcg	gcacgcccga	600

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cagcaccgtc cagaatccgc aggacgccag caagcccaac gacagccagt ccaacatcgc 660
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gcaggacacc aatcaggaac agcctgatag ccaggctcct ttccagaaca acggcgggct 780
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caacatcgcc atgaccgacg tcaaacacgc ctacgataaa acccaggcat cgacccaaca 1680
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<210> 11

<211> 344

<212> PRT

<213> *Ralstonia solanacearum*

<400> 11

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Asn Leu Asn Leu Asn Thr Asn Thr Asn Ser Gln Gln Ser Gly Gln Ser
      20              25              30

Val Gln Asp Leu Ile Lys Gln Val Glu Lys Asp Ile Leu Asn Ile Ile
      35              40              45

Ala Ala Leu Val Gln Lys Ala Ala Gln Ser Ala Gly Gly Asn Thr Gly
      50              55              60

Asn Thr Gly Asn Ala Pro Ala Lys Asp Gly Asn Ala Asn Ala Gly Ala
      65              70              75              80

Asn Asp Pro Ser Lys Asn Asp Pro Ser Lys Ser Gln Ala Pro Gln Ser
      85              90              95

Ala Asn Lys Thr Gly Asn Val Asp Asp Ala Asn Asn Gln Asp Pro Met
      100              105              110

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Gln Ala Leu Met Gln Leu Leu Glu Asp Leu Val Lys Leu Leu Lys Ala
 115 120 125
 Ala Leu His Met Gln Gln Pro Gly Gly Asn Asp Lys Gly Asn Gly Val
 130 135 140
 Gly Gly Ala Asn Gly Ala Lys Gly Ala Gly Gly Gln Gly Gly Leu Ala
 145 150 155 160
 Glu Ala Leu Gln Glu Ile Glu Gln Ile Leu Ala Gln Leu Gly Gly Gly
 165 170 175
 Gly Ala Gly Ala Gly Gly Ala Gly Gly Gly Val Gly Gly Ala Gly Gly
 180 185 190
 Ala Asp Gly Gly Ser Gly Ala Gly Gly Ala Gly Gly Ala Asn Gly Ala
 195 200 205
 Asp Gly Gly Asn Gly Val Asn Gly Asn Gln Ala Asn Gly Pro Gln Asn
 210 215 220
 Ala Gly Asp Val Asn Gly Ala Asn Gly Ala Asp Asp Gly Ser Glu Asp
 225 230 235 240
 Gln Gly Gly Leu Thr Gly Val Leu Gln Lys Leu Met Lys Ile Leu Asn
 245 250 255
 Ala Leu Val Gln Met Met Gln Gln Gly Gly Leu Gly Gly Gly Asn Gln
 260 265 270
 Ala Gln Gly Gly Ser Lys Gly Ala Gly Asn Ala Ser Pro Ala Ser Gly
 275 280 285
 Ala Asn Pro Gly Ala Asn Gln Pro Gly Ser Ala Asp Asp Gln Ser Ser
 290 295 300
 Gly Gln Asn Asn Leu Gln Ser Gln Ile Met Asp Val Val Lys Glu Val
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 Val Gln Ile Leu Gln Gln Met Leu Ala Ala Gln Asn Gly Gly Ser Gln
 325 330 335
 Gln Ser Thr Ser Thr Gln Pro Met
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<210> 12

<211> 1035

<212> DNA

<213> *Ralstonia solanacearum*

<400> 12

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gagaaggaca tctcaacat catcgagcc ctcgtgcaga aggcgcaca gtcggcgggc 180
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aacgacccga gcaagaacga cccgagcaag agccaggctc cgcagtcggc caacaagacc 300
ggcaacgctg acgacgcaa caaccaggat ccgatgcaag cgctgatgca gctgctgaa 360
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<212> PRT

<213> *Xanthomonas campestris*

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      20              25              30

Ser Ala Gly Ser Glu Gln Gln Leu Asp Gln Leu Leu Ala Met Phe Ile
      35              40              45

Met Met Met Leu Gln Gln Ser Gln Gly Ser Asp Ala Asn Gln Glu Cys
      50              55              60

Gly Asn Glu Gln Pro Gln Asn Gly Gln Gln Glu Gly Leu Ser Pro Leu
      65              70              75              80

Thr Gln Met Leu Met Gln Ile Val Met Gln Leu Met Gln Asn Gln Gly
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Asn Ala

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<211> 342

<212> DNA

<213> *Xanthomonas campestris*

<400> 14

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